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Canada's dairy industry is improving under production management (article, page 3).

L'industrie laitière s'améliore au Canada, par suite de la gestion de la production (voir article en page 3).



CANADA AGRICULTURE



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LA COMMISSION CANADIENNE DU LAIT

PROTOTYPE DE LA GESTION NATIONALE DE L'OFFRE

CANADIAN DAIRY COMMISSION PROTOTYPE OF NATIONAL SUPPLY MANAGEMENT

S. C. BARRY

The dairy industry in Canada is in a healthier state today than it has been for many years. Dairy farmers have reason to be confident of the future because they have arrived at a system of regulating supply and providing stability for the industry under a national supply management program.

Since the Canadian Dairy Commission was established under less fortunate circumstances in 1967, farm cash receipts from dairying have increased 23 percent. Price and subsidy improvements have been substantial during this period.

If we include subsidies in the calculations, the average price paid for manufacturing milk for five years before establishment of the Canadian Dairy Commission was \$3.25 per hundredweight, compared with \$4.95 for five years since the Commission was set up. This marks an improvement of 52 percent.

It is significant that the increase in farmer's returns was not fully dependent on subsidies, but rather on a sounder marketplace. To many farmers, price stability gained over this period was of greater importance than price improvement because it gave them confidence to plan for the future.

Of all the activities in which the Dairy Farmers of Canada have become involved, or taken the initiative, none has been of greater significance than the supply management program for manufacturing

S. C. BARRY

L'industrie laitière canadienne est plus florissante à l'heure actuelle qu'elle ne l'a été depuis de nombreuses années. Les éleveurs ont raison d'être confiants dans l'avenir. Ils sont arrivés à un point où l'offre peut être contrôlée et où l'industrie devient plus stable, grâce à un programme national de gestion de l'offre.

Depuis la création de la Commission canadienne du lait, dans des circonstances un peu moins heureuses, en 1967, les recettes en espèces des producteurs de lait ont augmenté de 23%. L'amélioration des prix et l'accroissement des subventions ont été fort importants pendant cette période.

En tenant compte des subventions, on trouve que la valeur du lait de transformation a été en moyenne de \$3.25 par quintal, au cours de la période quinquennale précédant la création de la Commission canadienne du lait, et de \$4.95 au cours des cinq années suivantes. Cela constitue une augmentation de 52%.

Il est bon de remarquer que l'augmentation des revenus des producteurs n'a pas fondamentalement reposé sur l'accroissement des subventions, mais a plutôt été le résultat d'une organisation plus saine du marché. Pour de nombreux producteurs de lait, la stabilité des prix à long terme a été encore plus importante que l'amélioration des prix en elle-même, car elle leur a permis de planifier leur opération en toute sécurité.

De tous les domaines dans lesquels les producteurs laitiers canadiens se sont trouvés impliqués, et où ils ont pris des initiatives, aucun ne s'est révélé plus important que le programme de gestion de l'offre du

Article based on paper delivered by S. C. Barry, Chairman, Canadian Dairy Commission, for the Minister of Agriculture, at a meeting of the Dairy Farmers of Canada in Hamilton, Ont., January 1972.

Cet article s'inspire d'une allocution prononcée par M. S. C. Barry, président de la Commission canadienne du lait, au nom du Ministre de l'Agriculture, lors du congrès de la Fédération des producteurs de lait du Canada tenu à Hamilton, en Ontario, en janvier 1972.

milk and cream instituted through the Canadian Dairy Commission. It is now close to being a truly national program due to response of the producers. Ontario and Quebec entered the program in December 1970, and Prince Edward Island on the same date in 1971. Alberta, Saskatchewan and Manitoba are making plans for the coming year.

CAN BE EXPANSIONARY

Supply management is designed to avoid surplus production with low prices in cycle with short production and high prices. It is interpreted by some as a restrictive device. But it can be expansionary if the demand justifies it.

Some may feel that supply management of dairy products has failed, based on performance last year. That's not so. Supplies in 1971 were sufficient to take care of all the market requirements for a wide range of dairy products, except for a small quantity of butter. Supplies included exports of a substantial quantity of cheese at a profitable price. It is quite probable that if prices and producer's returns at the beginning of 1971 had been the same as they were at the end of the year, there would have been no shortage at all.

In establishing a national dairy supply management program, the Dairy Farmers of Canada have demonstrated a willingness and ability to determine their future as an aggressive and modern industry. Others can do the same. The national marketing legislation enables producers to work together for a greater influence in the marketing of their products if they wish to do so. Supply management features of the bill are available immediately for poultry and poultry products producers. Others who wish these features will require an amendment of the act by parliament to do so.

A national marketing board can do much more than administer quotas. It can take many forms and assume many responsibilities depending on the needs of the group. One commodity group might require a board to coordinate an advertising campaign. One might require a negotiation board between producers and distributors. Another group might want to exercise supply management so that producers can meet the effective demand.

Marketing boards should, in effect, be salesmen. A salesman in any business is not restricted to an existing market. He promotes the use of a product, he seeks new markets, new opportunities, new forms and new uses for the product.

The dairy industry has an understandable interest in having its products used in external aid programs as other food commodity groups do. While dairy products have been and will be used in bilateral aid programs as required, the main Canadian contributions of dairy products in recent years has been through the World Food Program, under the FAO (Food and Agriculture Organization) of the United Nations.





lait de transformation et de la crème, instauré par la Commission canadienne du lait. Grâce aux efforts des producteurs de lait, ce programme est maintenant très près de devenir vraiment national. L'Ontario et le Québec y ont participé dès décembre 1970, l'Île-du-Prince-Édouard à la même date en 1971. L'Alberta, la Saskatchewan et le Manitoba l'envisagent pour cette année.

POSSIBILITÉS D'EXPANSION

La gestion de l'offre a pour but d'éviter la surproduction qui s'accompagne d'une baisse de prix, qui à son tour amène une basse production et des prix élevés. Certains croient qu'il s'agit d'un instrument de limitation de la production. Au contraire, il peut amener une expansion si la demande le justifie.

Plusieurs pensent que la gestion de l'offre n'a pas joué son rôle l'an dernier. C'est faux. En 1971, les disponibilités étaient suffisantes pour satisfaire à tous les besoins du marché en ce qui a trait à une vaste gamme de produits laitiers, sauf le beurre dont il manquait une petite quantité. Nos disponibilités comprenaient une quantité importante de fromage qui a été exportée, pour le plus grand bénéfice des producteurs. De fait, il est probable que si les prix et les revenus des producteurs au début de 1971 avaient été les mêmes que ce qu'ils étaient à la fin de l'année, il n'y aurait eu pénurie d'aucun produit laitier.

Par l'établissement d'un programme national de gestion de l'offre des produits laitiers, la Fédération des producteurs de lait du Canada a démontré une volonté et une capacité de décider de son avenir comme le fait une industrie dynamique et moderne. D'autres peuvent en faire autant. La loi nationale régissant la commercialisation permet aux producteurs de travailler ensemble à l'accroissement de leur influence dans la commercialisation de leurs produits. Les producteurs de volailles et de produits de la volaille peuvent dès maintenant se prévaloir des dispositions de la loi sur la gestion de l'offre. Les autres producteurs qui désireront tirer profit de ces dispositions devront exiger du Parlement un amendement à cette loi.

Les offices nationaux de commercialisation peuvent faire plus que d'assurer l'administration des contingents. Ils peuvent prendre plusieurs formes et assumer les charges suivant les besoins particuliers de chaque groupe. Un groupe de producteurs d'une denrée peut avoir besoin d'un office à la seule fin de coordonner une campagne de publicité. On peut avoir besoin d'un office de négociation entre producteurs et distributeurs. Un autre groupe peut encore vouloir exercer une gestion de l'offre de façon à ce que les producteurs puissent satisfaire à la demande réelle.

Les offices de commercialisation sont, de fait, des vendeurs, et comme dans toute affaire, les vendeurs ne sont pas limités aux seuls marchés déjà existants. Ils encouragent l'usage d'un produit, sont à la recher-



Canada's skim milk powder is being used in food-short areas of the world.

Le lait écrémé en poudre fabriqué au Canada est consommé dans plusieurs pays sous-alimentés à travers le monde.

Under the World Food Program, Canada has provided 31 million pounds of skim milk powder, 16 million pounds of canned cheese, 3 million pounds of evaporated milk, two and a half million pounds of whole milk powder and one and a half million pounds of butter oil.

MARKET INTELLIGENCE

Another way in which government is involved in national marketing boards such as the Canadian Dairy Commission is in market intelligence. Producers need reliable information on both international and domestic markets.

Market intelligence comes from statistics that the Commission collects from Canadian and foreign sources, and analyzes for the benefit of the industry. Market intelligence also comes from personal contacts with the trade at the grass roots level. The Commission uses these contacts on a national and international scale.

Many producers have already benefited from appraisals of the Canadian Dairy Commission. However, this area has been extended with creation of a new position in the marketing section to be involved specifically with market developments and intelligence. The Commission, also, is strengthening its economics section.

Many sections of Canadian agriculture are coming increasingly to the view that if they are to provide stability for their industries, they must have some means to adjust supplies to the effective demand. Dairy farmers are pioneering this effort in Canada through a national marketing commission. ■

che de nouveaux marchés, de nouvelles occasions, de nouvelles formes et de nouveaux usages pour les produits.

L'intérêt porté par l'industrie laitière à l'utilisation de sa production par les programmes d'aide extérieure où les organismes utilisent des denrées alimentaires est compréhensible. Nos produits laitiers ont été et continueront à être utilisés par les programmes d'aide bilatérale, en fonction des besoins, mais au cours des années récentes la principale contribution apportée par le Canada aux différents organismes, sous forme de produits laitiers, s'est faite dans le cadre du Programme alimentaire mondial de la F.A.O. (Organisation pour l'alimentation et l'agriculture) des Nations Unies.

Dans le cadre du Programme alimentaire mondial, nous avons fourni 31 millions de livres de lait écrémé en poudre, 16 millions de livres de fromage en boîtes, 3 millions de livres de lait évaporé, 2,500.000 livres de lait entier en poudre et 1,500.000 livres de beurre fondu liquide.

CONNAISSANCE DU MARCHÉ

Un autre domaine dans lequel le gouvernement se trouve impliqué en ce qui concerne les offices de commercialisation du type de la Commission canadienne du lait, est celui de la connaissance du marché. Les producteurs ont besoin de renseignements valables au sujet des marchés intérieurs et internationaux.

La connaissance du marché découle des statistiques d'origine canadiennes et étrangères, obtenues par la Commission qu'elle analyse ensuite au bénéfice de l'agriculture.

La connaissance est constituée aussi par des contacts personnels, souvent les plus valables. En cette matière, également, la Commission est très active, sur le plan national et international.

De nombreux producteurs ont déjà bénéficié des évaluations de la Commission; toutefois ce domaine a été élargi par la création d'un poste supplémentaire à la section de commercialisation dont le titulaire s'occupera spécifiquement de la connaissance et de l'exploitation du marché. Dans le même esprit, la Commission renforce sa section économique.

Un grand nombre de secteurs de l'agriculture canadienne admettent de plus en plus que s'ils veulent jouir d'une certaine stabilité, il leur faut disposer de moyens permettant d'ajuster l'offre à la demande réelle. Dans ce domaine, les producteurs de lait par leur commission nationale de commercialisation, sont des pionniers au Canada. ■

Afin de tirer parti au maximum des parasites et des prédateurs, dans la lutte contre la tordeuse orientale du pêcher et contre le tétranyque rouge du pommier, on a élaboré un programme réduit de pulvérisations, à la Station de recherches du ministère de l'Agriculture du Canada, à Vineland. On a réduit de cinq à deux le nombre de pulvérisations d'insecticides, tandis que les pulvérisations d'acaricides ont été réduites ou éliminées complètement.

If integrated pest control is considered in its more limited sense of harmonizing biological and chemical control, then we have made considerable progress at the CDA Research Station, Vineland, Ont.

Up to 6 regular insecticides, 2 miticide and at least 6 fungicide sprays are recommended annually for peach orchards in the Niagara Peninsula. In addition, special sprays for tarnished plant bug and peach tree borer are applied where these insects are a problem. Cost of this spray program, depending on the number of sprays, and the pesticides used, ranges from \$50.00 to \$130.00 per acre for chemicals alone. Obviously, any method of reducing this cost, and still providing acceptably clean fruit, would be of benefit to peach growers.

Dr. Phillips is Program Leader for peach pests at CDA Research Station, Vineland, Ont.

PEACH PESTS

The number of insects normally attacking peach in Ontario are relatively few. The most important is the oriental fruit moth, introduced into the Niagara Peninsula about 1925. The larvae of this moth bore into both the twigs and fruit. There are three generations in Ontario. When the fruit moth was first introduced there was no effective means of control and the end of peach growing in the Peninsula was predicted. However, by 1932 a combination of biotic and abiotic mortality factors had reduced the moth to low numbers. A second outbreak occurred from 1945 to 1948, but by 1948 DDT was available and provided effective control. More recently phosphate and carbamate insecticides have replaced DDT.

Many native parasites attack the fruit moth, the most important being *Glypta rufiscutellaris* Cress., which may parasitize up to 40% of second generation larvae. In 1929 the parasitoid wasp, *Macrocentrus ancylivorus* Rohwer, was introduced from the U.S.A. and soon became the dominant parasite destroying large numbers of first and second generation fruit moth larvae in peach twigs. Larvae that attack the fruit usually escape parasitism. Parasitism by *M. ancylivorus* has remained high in spite of the general use of insecticides for fruit moth control, but parasitism by *G. rufiscutellaris* has been greatly reduced. However, even high levels of parasitism do not reduce fruit injury to an economic level, especially on late maturing cultivars attacked by third generation larvae.

Other pests which may cause considerable injury include the peach tree borer, tarnished plant bug and plum curculio. None of these insects require routine spraying for their control. Borers can be controlled by treatment of planting stock plus additional trunk and limb sprays when they become a problem. Tarnished plant bug and curculio are usually limited to certain problem areas and only occasionally cause widespread injury. If the orchard is examined regularly, sprays can be applied to give adequate control of both these pests.

Prior to the 1960's, the peach twig borer was considered a minor pest of peach. It bores into twigs



INTEGRATED
CONTROL OF
PESTS ON PEACH . . .

ON THE
NIAGARA PENINSULA
ONTARIO

early in the season causing injury similar to that of the fruit moth. Later generations also attack the fruit causing large unsightly gummy areas. Injury by this pest has occurred wherever early insecticide sprays have been omitted on peach. There is evidence that the parasite of the borer has been reduced or eliminated by spray programs.

The European red mite was not a major problem in peach orchards prior to the 1940's. Unsprayed orchards still have no, or very few red mites. Sulphur fungicides, and almost all the commonly used insecticides favor the development of red mite by suppressing the mite's predators. The ability of the red mite to develop resistance quickly to chemicals used for its control has created control problems.

Less important pests of peach are, green fruit worms, brown mites, peach silver mites, leaf hoppers and aphids. The peach silver mite may be an important alternative food for predaceous insects and mites that attack the red mite. Brown rot is the most important fungal disease attacking peach fruit. Both blossom and fruit are affected. Prolonged wetting at blossom time and warm humid conditions at harvest can produce severe brown rot injury. During the 30's, sulphur wettable powders and pastes replaced lime sulphur for brown rot control. Though sulphur is still extensively used, Captan is also recommended and is less damaging to mite predators.

DEVELOPMENT OF THE PROGRAM

Control of the oriental fruit moth is essentially

Injury caused by an oriental fruit moth larvae boring into a peach twig.

External fruit moth injury on a peach fruit.

Peach fruit showing extensive internal feeding by oriental fruit moth.

Peaches injured by peach twig borer.

Catfacing, gumming and scarring of peaches caused by tarnished plant bug feeding.

Glypta rufiscutellaris Cress. A native parasite of the oriental fruit moth.

protection of the fruit from injury. Though twig damage may be extensive, especially on young trees, it has not been shown to be generally harmful. There are even indications that by limiting terminal growth and forcing development of lateral shoots, fruit moth injury may improve the growth habit of peach trees. To utilize parasites in a control program, some twig injury is necessary, because the fruit moth larvae in twigs are the most heavily parasitized. Fruit injury results from either direct invasion by first instar larvae or secondary injury by partly grown larvae that first invaded twigs. Direct injury by early stage larvae, which is the most important, is uncommon till just before the fruit starts to ripen. When immature fruits are attacked they produce copious gum which drowns small larvae. Secondary injury is usually marked by large accumulations of frass and gum on the fruit. Injury by larvae that invade fruit just before it begins to soften is usually difficult to detect externally because the fruit does not produce gum at that stage. Fruit that externally appears sound may be useless because of extensive internal damage.

A management program that would allow parasites to develop in larvae in the twigs and that would use only one spray to protect the ripening fruit seemed a reasonable possibility. Several years' experience with such a program in light to moderate infestations of fruit moth showed that acceptable control could be obtained with rates of insecticide below those being recommended. However, total insect injury was higher than desirable and because of this, brown rot incidence increased. The addition of an early post-blossom spray to the program, to control early-feeding insects, reduced total insect injury to acceptable levels.

A tolerance for injury to fruit had to be set, if the fruit moth population was to be large enough to maintain an effective parasite population. This level was set at 2% injury for early, and 5% injury for mid-season and late cultivars. This is lower than the per-



centage fruit injury found in many orchards where the currently recommended spray program is used. Guthion at 15 oz per acre and Imidan at 3 lb per acre both gave adequate control of the fruit moth in the two-spray program, but Imidan was much less damaging to mite predators. The fungicide Captan and insecticide Imidan were therefore chosen because they were innocuous to predators.

Without the use of miticides, red mite would soon reach excessive numbers in most commercial peach orchards. However, many more mites can be tolerated on peach trees than insects which attack the fruit directly. To maintain mite predators, an upper level of mite tolerance was set at an average of 5 adult mites per leaf. At this average level, because of the uneven distribution of the red mite, some trees will show easily visible mite injury. In 1971, in two commercial orchards in which the reduced insecticide program was used, red mite reached the 5 per leaf level the second week of July. A single spray of Omite at 5 lb per acre reduced but did not eliminate the infestation and the red mite numbers remained low. Red mite predators were present but scarce throughout the treated orchards.

MONITORING INSECT NUMBERS

If a minimum protection spray program is to be effective, a method to determine the need for spraying is required. The method should be simple and reliable if growers are to use it. For many years bait traps containing a brown-sugar solution plus terpinyl acetate have been used in the Niagara Peninsula to determine optimum spray dates to control the fruit moth. More recently sex lure traps have been used. One year's trial indicates that they are as effective as the bait traps and are easier to use. Traps can be used by a grower to indicate maximum activity of adult moths and the time to spray for maximum effect. However, the numbers of moths caught cannot easily be related to the total moth population; nor do

they indicate the probability of excessive fruit injury. This is because traps measure both activity and numbers, and may attract moths from surrounding areas. Other insects and mites may be monitored by tapping branches or by visual inspection of the orchard. Growers should soon learn those areas within their orchards in which certain pests are likely to occur.

THE INTEGRATED CONTROL PROGRAM

In the integrated control program now being tested in commercial orchards the number of routine insecticide sprays is reduced to two: one at 50% shuck fall to control early feeding insects; the other 12 to 14 days before harvest of those cultivars ripening after August 1, to protect the ripening fruit from direct injury. A dormant spray for leaf curl, and brown rot sprays, are applied as currently recommended. Only pesticides relatively innocuous to red mite predators are used, including Ferbam in the dormant spray, Captan for brown rot control, and Imidan as the insecticide. Miticides are used only when necessary. Insect numbers are monitored throughout the season in each orchard. This program should cost about half that of the spray program currently being recommended and greatly reduce the amount of insecticide used.

To assist growers in achieving control without serious red mite problems, a transitional spray program consisting of three insecticide sprays and one miticide spray when necessary is being suggested for 1972. This program can be adopted by a peach grower without monitoring for any pests except red mite. A miticide such as Omite would be applied when some trees in the orchard first show easily visible mite injury. Such a program, I believe, will allow a grower to reduce the number of pesticide sprays in his orchard and gradually eliminate the need for miticides entirely. When mite predators become reestablished in the orchard the integrated control program may be adopted. ■



Maintenant, grâce à la phéromone synthétique qui attire les mâles de la pyrale de la pomme, les chercheurs peuvent poursuivre leurs programmes de recherches pour estimer la densité de population dans les vergers et ainsi déterminer si les traitements par pesticides sont nécessaires.

It has been known for several years that female codling moths attract males by a chemical scent called a sex pheromone. In the presence of this pheromone, male moths are stimulated to fly towards the female until she is located. The pair then mate, and the female lays her fertilized eggs shortly thereafter.

In the program to control codling moth by release of sterile males, virgin females caged in traps lined with a sticky substance are used to capture both native males and released sterile males. Released males are marked with a fluorescent dye so they can be distinguished from natives and the ratio of released males to native males can be established.

The use of female-baited codling moth traps in apple orchards as an aid to control has been investigated at Summerland for three years. Field studies have been limited because of the labor involved in maintaining female-baited traps and the need for large numbers of female codling moths. This situation suddenly changed in 1971 when the codling moth sex pheromone was isolated and identified by researchers at Cornell University. A limited quantity of the synthetic pheromone was available in 1971 and field evaluation tests were conducted at Summerland to compare pheromone traps to traps baited with virgin female codling moths. The synthetic sex pheromone at a rate of 1 mg. applied to a 2¼" x ½" piece of rubber band was more attractive to males than were virgin females. The pheromone remained attractive in the field for 79 days with a single 1 mg. dose.

PHEROMONE TRAPS

The availability of an effective sex pheromone for the codling moth, its persistence in the field and its attractiveness to native males indicates several practical uses. One obvious possibility is to use pheromone traps to attract and destroy male codling moths. If all the males in a given area were attracted to pheromone traps, females could not mate and no viable eggs would be laid. Another approach is to saturate the atmosphere with pheromone, thus creating an environment where males could not orient to females. Neither of these methods of control has been evaluated in the field, but tests will be made in

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CODLING MOTH SEX TRAPS— THEIR POTENTIAL USE IN APPLE ORCHARDS





Codling moth sex pheromone trap.



1972 when the synthetic sex pheromone is readily available.

A very practical use of sex lures, and one which has been under study at Summerland, is to estimate the population density of codling moths in an orchard and thus determine if pesticide treatments are necessary. At the present time, sprays are applied routinely, and if a population level requiring treatment can be established, growers would realize a considerable saving in production costs. Two years of study in grower orchards has indicated that if male

moth captures do not exceed two per week in any one trap, sprays are not required. Thus far, one trap per acre has been sufficient to sample an orchard as long as the traps are evenly distributed. In 1971, traps were installed in a 13-acre commercial apple orchard and used to determine the need for sprays. Male moth captures remained below two per trap per week until late August when captures rose to above two in a few traps and fresh codling moth entries were found in the fruit. In order to stop a potential infestation, a codling moth spray was applied on September 6. An examination of the fruit at harvest showed less than 0.5 percent infested apples. By basing the need for codling moth sprays on pheromone trap captures, only one late spray was required rather than a standard schedule of three applications. Eliminating the spring and summer treatments resulted in an increase of beneficial insects and mites in the orchard and both plant feeding mites and aphids were controlled biologically.

INJURIOUS INFESTATION

As a comparison, traps were installed in a portion of the Summerland Research Station orchard where an injurious level of codling moths was known to be present. The orchard was not sprayed, and the pheromone traps captured an average of 11 male codling moths per trap per week. At harvest, the codling moth infestation was 12.7 percent.

These data indicate that sex pheromone traps can be used to estimate codling moth population levels in apple orchards. A synthetic pheromone will allow an expansion of the program since the traps will need little maintenance and can be quickly prepared. In all probability, traps containing pheromone will be commercially available by 1972 or 1973, but there is need for further research before the traps can be recommended to growers. The synthetic pheromone may require less traps per acre than female-baited traps and the distribution of traps within an orchard could be less or more critical. Interpretation of the data is most important and further experiments are necessary to define the precise codling moth population level that requires chemical control. One of the major unsolved problems is to determine the effective distance that synthetic pheromone traps will attract males. Traps in one orchard may attract moths from neighboring orchards and thus give a false impression of the population within that orchard. Several types of traps have been used to attract and capture males, and not all are equally efficient. A standard trap must be designed so that data are comparable from one orchard to the next.

Research to resolve the problems outlined above is planned for the coming season, and it is expected that sex pheromone traps will become an essential part of pest management in apple orchards. ■

Il a été prouvé que l'herbe déshydratée est un aliment d'excellente qualité pour les vaches laitières lorsqu'elle est ajoutée à un ensilage de maïs à haute teneur en humidité puisqu'elle incite à une plus grande consommation de matière sèche et augmente la production de lait et de matières sèches dégraissées. Quand 15% des céréales ont été ôtées, l'herbe déshydratée a fourni la majeure partie des protéines brutes de la ration et une valeur énergétique comparable à celle des céréales.

One of the objectives of dairy cattle nutrition research at the CDA Research Station, Agassiz, B.C., is to study the factors that influence silage corn consumption by high-producing dairy cows, and to develop ways of increasing consumption and efficiency of utilization of forage corn nutrients in milk production.

Research started with an experiment to determine the effect of moisture content of ensiled corn forage on dry matter (DM) intake, milk production, and milk composition. A 15% increase in dry matter intake was observed in milk cows when corn silage at 29% DM was fed, compared with the same silage at 24% DM. Milk production was 3% greater on the high DM corn silage, than on the low. Feeding seven pounds of hay daily, along with the wet silage, resulted in forage consumption equal to that of cows fed the low moisture silage plus hay. Small differences still exist in milk production in favor of the cows fed low moisture silage plus hay.

In the preceding experiment we were not satisfied with the total feed intake of the holstein cows and thought that a different method of feeding might result in higher levels of forage consumption. We were also looking for a feed that would supply additional protein at an economic level, to supplement the low protein content of the corn silage. Dehydrated grass, a 20 to 24% crude protein, low fiber product, was available from commercial dehydration plants in the Fraser Valley. Dehydrated grass was blended with cereal grains and a small amount of urea plus minerals at a commercial feed plant, then mixed with corn silage at the station and fed as a "complete" feed to lactating cows. Two complete feeds containing grain, dehydrated grass (dehy), and corn silage were compared to a control ration of free-choice corn silage. 7 pounds of hay daily and a grain mixture fed according to milk production. On a dry matter basis the two complete feeds contained: 1) 25% grain, 55% dehy, 19% corn silage; 2) 40% grain, 41% dehy, 19% corn silage. The cows fed the control ration consumed 39% of their total dry matter as grain and 61% as forage.

Dr. Waldern is the dairy cattle management and nutrition officer at CDA Research Station, Agassiz, B.C.



MAXIMUM USE OF CORN SILAGE

Feed consumption and performance were excellent on the complete feeds, as shown in Table 1. Dehydrated grass proved to be an excellent material to add to high moisture corn silage, as it resulted in increased dry matter consumption as well as greater milk and non-fat solids production. The dehy also provided the major portion of crude protein in the ration, and had an energy content comparable to that of grain, when 15% of the grain was replaced by dehy (40% grain complete feed vs 25% grain complete feed).

In other experiments we investigated the ability of the dairy cow to utilize the protein (nitrogen) in corn silage when it was supplemented with urea, a low cost non-protein nitrogen source. Dehydrated grass, when used as a carrier for urea, was found to improve by 25%, the efficiency of nitrogen utilization by the lactating cow.

Grain content as a percentage of whole corn-plant dry matter content is another aspect of forage corn utilization that is important to the dairyman who is faced with high costs of supplemental grain. Existing research information had led us to believe that a) maturity of the corn plant at time of harvest, and b) moisture content, were the only factors to be con-



DAIRY CATTLE RATIONS

cerned about. However, we set out to determine whether high producing cows, fed 30% dry matter forage corn silages, would respond to differences as low as 10% in the grain content of ensiled materials. Four groups of cows were fed either of the following silages: 1) low grain corn silage (30% of the total plant dry matter was corn grain); 2) high grain corn silage (39% corn grain). Two groups of cows (one group on each silage type), were fed a meal (con-

trate) mixture at 1 lb of meal to 3.5 lb of 4% fat-corrected milk produced, while the other two groups were fed meal at 1:5.0. Our results indicated that high producing cows, fed a high grain corn silage (39%) and concentrate at 1:5.0, would produce as much milk as those fed a low grain corn silage (30%) and concentrate at 1:3.5.

Animals offered free choice high grain silage out-produced those fed low grain corn silage if both groups were offered concentrate at 1:3.5 or 1:5.0. Based on this data, a dairyman milking 100 cows averaging 50 lb milk per cow per day would require an additional 6½ tons of purchased supplemental concentrate per month if he were to obtain a level of milk production from a low grain corn silage comparable to that he could obtain from a high grain corn silage.

Based on the research results obtained in all the above experiments we attempted to formulate "ensiled complete feeds" for lactating cows. In this work urea, dehydrated grass, rolled grain, and minerals were blended with 30% dry matter forage corn at time of harvest and stored in conventional wood stave silos. Different levels of grain ranging from 30 to 55% of the total dry matter ensiled have been used in order to study energy needs of lactating cows fed in this manner. Dry matter content of these ensiled complete feeds at time of feeding has ranged from 40 to over 50%. Our first feeding, digestion and nitrogen balance experiments have recently been completed and only a limited amount of data are available. We have noted with interest that some cows were consuming over 4.5 lb of dry matter per 100 lb of body weight daily when fed the complete feeds. We generally consider an intake of 3.0 to 3.5 lb of dry matter per 100 lb of body weight as being good under conventional feeding conditions.

Newer methods of maximizing corn silage intake, nutrient intake, and utilization for more efficient performance by the high-producing dairy cow are in the developmental stages. Further research is required with these animals to determine specific energy levels required in "complete" feeds to meet the demands of cows at different levels of milk production and different stages of lactation. Offering dairy cows complete feeds lends well to accurate feeding according to milk production needs when cows are housed by production groups under practical farm conditions. In-depth research is needed to establish mineral requirements and effects of mineral interrelationships on performance, reproduction, and longevity where cows are fed in this manner under dry lot conditions for their lifetime.

The ability of lactating cows to utilize efficiently different sources of non-protein nitrogen when mixed with a carrier such as dehydrated grass presents new avenues for research. ■

TABLE 1. DAILY FEED INTAKE AND PERFORMANCE ON CORN-SILAGE-BASED DEHYDRATED GRASS COMPLETE FEEDS

	Complete feeds		Control
	25% grain 56% dehy-grass 19% silage	40% grain 41% dehy-grass 19% silage	Grain Hay - 7 lb Corn silage free choice
Dry matter intake per 100 lb body wt. (lb)	3.62	3.75	3.15
% fat corrected milk (lb)	55.2	55.5	50.9
Milk fat (%)	3.8	3.8	3.8
Milk protein (%)	3.33	3.31	3.11
Non-fat solids (%)	5.10	5.18	4.88



FLOCONS DE FRUITS À SAVEUR INTACTE

FULL FLAVORED FRUIT FLAKES

The author taste-tests dry fruit sauce products in CDA's Summerland test kitchen.

L'auteur goûte les sauces aux fruits déshydratées, dans la cuisine expérimentale du ministère de l'Agriculture, à Summerland.



Commercial production of high quality "instant" dry fruit-sauce flakes could result in a new market outlet for Canadian grown berries and tree fruits.

At the CDA Research Station, Summerland, B.C., we have developed a low cost method of drying purees such as apple, apricot, blueberry and at the same time separately capturing their natural aromas in dry form. By mixing together the dry sauce and dry aromas we have a full flavored product. This can be eaten directly after reconstitution with cold water, or formed into small tablets and used in cake and muffin mixes, or converted into larger tablets or flakes for use with breakfast cereals.

Ideas for the process improvements arose from our research on drying fruit purees to moisture levels of 2% or less. We knew that one of the most efficient and economical ways to do this was with a double drum drier, similar to that used in producing powdered milk. However, we found that during the 20 second high temperature drying cycle on our laboratory drum drier, 80% or more of the aromas in a product such as applesauce were evaporated along with the water. Sauce made by reconstituting the dry product with water had good color but had lost its characteristic aroma and flavor.

CONDENSED AROMA

At first we attempted to collect the lost aroma by condensing the vapor evaporated from the drum drier. This idea proved to be unworkable so we devised a simpler system of stripping and condensing fruit aroma directly from freshly prepared sauce. In this system we heated the sauce to an above boiling temperature of 220°F and released the super heated sauce into a vapor-liquid separator. From the separator, the sauce, concentrated to 90% of its original weight and, essentially stripped of its aroma, was fed onto the drum drier and converted to dry flakes. The water vapor containing all the captured aroma was collected from the separator and condensed. We concentrated this weak aroma solution in two stages. The first stage consisted of a conventional fractionating column. This yielded aroma concentrate 150 times as strong as in the original fruit. This 150 fold essence was further concentrated in a specially designed vacuum aroma column to approximately 20,000 times its original strength. Approximately 1.5 ounces of this oily liquid contains all the aroma from a ton of fruit.

We originally considered mixing aroma concentrate directly with dry flakes. However, this had two disadvantages: it was difficult to distribute the liquid evenly in a large volume of dry flakes and, the aroma, being relatively volatile, was lost in storage.

La production commerciale de flocons séchés de sauce aux fruits "instantanée" de haute qualité pourrait représenter un nouveau débouché pour les baies et les fruits cultivés au Canada.

A la station de recherche du ministère de l'Agriculture du Canada, à Summerland, nous avons mis au point un procédé économique de déshydratation des purées de fruits tels que pommes, abricots et bleuets, qui permet de recueillir séparément, sous forme sèche, les arômes naturels. Le mélange de la sauce et des arômes donne un produit qui n'a rien perdu de sa saveur naturelle. On peut le consommer directement en y ajoutant de l'eau froide, le façonner en petits comprimés que l'on incorporera aux mélanges à gâteaux et à muffins ou encore l'ajouter, en tablettes ou en flocons, aux céréales du petit déjeuner.

L'idée d'une transformation plus poussée est née des recherches que nous poursuivions sur la réduction à 2% et moins de la teneur en humidité des purées de fruits. Nous savions que l'un des moyens les plus efficaces et les plus économiques d'atteindre cet objectif était d'utiliser un séchoir à deux tambours, semblable à celui qu'on emploie dans la fabrication du lait en poudre. Nous avons découvert, cependant, qu'au cours du cycle de 20 secondes de séchage à haute température sur le séchoir à tambours du laboratoire, 80% ou plus de l'arôme du produit, en l'occurrence de la sauce aux pommes, s'évaporait en même temps que l'eau. La sauce qu'on reconstituait par addition d'eau au produit séché avait belle apparence, mais avait perdu sa saveur et son arôme naturels.

ARÔME CONDENSÉ

Nous avons commencé par essayer de recueillir l'arôme perdu, par condensation de la vapeur d'eau qui s'échappait du séchoir. Devant l'inefficacité de cette méthode, nous avons mis au point un procédé plus simple consistant à extraire l'arôme du fruit directement de la sauce fraîche et à le condenser. Après avoir porté la sauce à 220°F, au-delà du point d'ébullition, nous l'avons fait passer dans un séparateur d'eau et de vapeur. Réduite à 90% de son poids original et essentiellement privée de son arôme, elle a ensuite été versée sur le séchoir à tambours et transformée en flocons séchés, pendant que la vapeur d'eau chargée d'arôme était recueillie et condensée. Nous avons concentré cette faible solution d'arôme en deux étapes: d'abord dans une colonne de fractionnement ordinaire, où elle a acquis 150 fois la teneur du fruit naturel, puis de là dans une colonne à vide spécialement conçue pour obtenir environ 20,000 fois la force de l'essence originale. Une once et demie de cette huile contient à peu près la valeur en arôme d'une tonne de fruits.

The author is Acting Head, Food Processing Section, and a specialist in food technology with the CDA Research Station, Summerland, B.C.

M. Kitson, chef adjoint de la section du traitement des aliments, est spécialiste des techniques alimentaires à la station de recherches de Summerland, en Colombie-Britannique.

As an alternative to direct mixing we have devised a system of locking the aroma concentrate into a stable dry powder and mixing this with dry fruit sauce. Starting point of this locking process is the preparation of a sugar polymer. This we accomplish by heating and mixing together sucrose and some form of low conversion corn syrup. By careful control of reaction time and temperature, these sugars combine to form a viscous fondant-like paste containing various complex polymerized sugars. The paste is cooled and mixed with the high strength essence and a small quantity of glycerin binder. Finally we whip the sugar polymer-aroma mix into a foam and dry the foam at low temperature under vacuum to form a meringue-like cake. This cake is ground to form the aroma powder. Fruit volatiles remain locked in the essentially aroma-free powder until they are released by adding water during rehydration. We have made powders of up to 250-fold strength by this method.

To prepare aroma-enriched sauce flakes we mix the low moisture, drum dried puree with a small amount of the dry aroma powder. For example 1/15 ounce of 250-fold apple aroma powder mixed with 2 1/3 ounces of applesauce flakes yielded a pound of full flavored reconstituted sauce.

Flavored sauce flakes may be reconstituted and eaten as desserts or, in the case of light colored products such as pear, apricot or apple, combined directly with the dry ingredients in cooked breakfast cereals, cake, muffin or pancake mixes. Intensely colored berry-sauce flakes naturally cannot be used in their original form in baked goods. Compressed into beadlets, however, they can be used to add eye catching splashes of color and delicious fruit flavor to many kinds of baked goods. Still another potential use we have found for flavored flakes is to form the flakes into discs about the size of banana slices. These slices may be packaged with dry cereal flakes to provide a new form of fruit with breakfast. ■

Nous nous proposons au début, de mélanger directement l'arôme concentré avec les flocons séchés. Or cette méthode comportait deux inconvénients: d'une part, il était difficile de répartir le liquide uniformément dans une masse considérable de flocons et, d'autre part, l'arôme, produit assez volatil, s'évaporait à l'entreposage. Nous avons alors mis au point un procédé permettant d'emprisonner l'arôme concentré dans une poudre stable et de mêler celle-ci à la sauce de fruits déshydratée. La phase initiale de cette transformation consiste dans la préparation d'un polymère du sucre, qu'on obtient en chauffant et en mêlant du saccharose à un type de sirop de maïs faiblement hydrolysé. Soumis à un contrôle rigoureux des temps de réaction et des températures, ces sucres se combinent pour former une pâte visqueuse à consistance de fondant, qui contient plusieurs structures complexes de sucres polymérisés. Une fois la pâte refroidie, on y incorpore de l'essence à haute concentration ainsi qu'une petite quantité d'un agglutinant à la glycérine. Enfin, on bat ce mélange jusqu'à former une mousse qu'on sèche ensuite sous vide à basse température pour obtenir une sorte de meringue. On réduit ce gâteau en poudre, d'ailleurs presque inodore, où les composants volatils des fruits demeurent emprisonnés jusqu'à la réhydratation. Nous avons fabriqué de cette façon des poudres possédant jusqu'à 250 fois la valeur aromatique du fruit naturel.

Pour préparer des flocons de sauce à saveur riche, nous mélangeons la purée traitée sur le séchoir à tambours avec un peu de poudre aromatique. C'est ainsi que 1/15 d'once de poudre à saveur de pommes, à indice de concentration 250, incorporé à 2 1/3 onces de flocons de sauce aux pommes a donné, après reconstitution, une livre de sauce à saveur intacte.

Ces flocons peuvent être réhydratés et dégustés en desserts ou, dans le cas de produits à couleur claire tels que poires, abricots ou pommes, mêlés directement aux ingrédients secs des céréales cuites du petit déjeuner, des mélanges à gâteaux, muffins ou crêpes. On ne peut évidemment employer, sous leur forme originale, des flocons de sauce de baies très colorées dans les pâtisseries. En petites "perles", cependant, ils peuvent leur ajouter d'agréables notes de couleur et une délicieuse saveur de fruits. Une autre façon d'utiliser les flocons serait de les façonner en rondelles de la grosseur d'une tranche de banane et de les inclure dans les boîtes de flocons de céréales, forme nouvelle de repas matinal aux fruits. ■

In Saskatoon's CDA Research Station laboratory John Capcara, technician (left), injects a chemically processed rapeseed oil extract into the chromatograph injection port, while Dr. Keith Downey, rapeseed breeding specialist, reads the resulting graph (lower right), and the integrator's calculations on tape (upper right). With the aid of these sophisticated instruments, CDA laboratories can determine the erucic acid content of rapeseed stocks.

ERUCIC ACID TESTING OF RAPESEED



Le marché de l'huile de colza à faible teneur en acide érucique prend de plus en plus de vigueur. La Division des produits végétaux du ministère de l'Agriculture du Canada a maintenant l'équipement nécessaire pour vérifier, classer et emballer les semences de colza pour la plantation du printemps. On ne mettra en terre que des semences certifiées par la Division pour produire le colza à faible teneur en acide érucique. A l'aide d'un équipement très complexe, récemment installé dans les laboratoires du Ministère à Ottawa et dans les Prairies, on peut déterminer la teneur du colza en acide érucique et on peut également créer des variétés de semences d'une composition chimique particulière.

The Analytical Services Section of Canada Department of Agriculture's Plant Products Division has installed new testing equipment at CDA Research Station laboratories in Ottawa and on the Prairies. The equipment is used to analyze the erucic acid in rapeseed oil. The analysis is essential to establish the purity of pedigreed low erucic rapeseed (LEAR) varieties.

Stories on the development of the rapeseed industry were carried in the Fall '71 and the Winter '72 issues of *Canada Agriculture*.

Until market prospects became clear, rapeseed growers were hesitant to have their crops tested. Now, however, current assessments of Canada's need for LEAR varieties tie in with reports from overseas trade missions to indicate that LEAR oil has a booming market potential.

Only certified seed should be planted for LEAR production, and the erucic content of such seed must be checked, graded and sealed by CDA's Plant Products Division, before spring planting.

The test technique for rapeseed was developed by Dr. B. M. Craig, director of the National Research Council's Prairie Regional Laboratory in Saskatoon. The laboratory is linked with the local CDA Research Station in co-operative research on methods of identifying rapeseed components and building new varieties of seed with unique chemical composition.

Testing equipment, newly installed at CDA Research Station laboratories, consists of gas chromatographs and electronic integrators. A gas chromatograph is a highly sensitive, sophisticated analytical instrument which separates chemical compounds in a mixture, and records them quantitatively as a series of peaks on a chart. The integrator is a type of electronic calculator that measures the area of each peak and prints it out as a numerical value. From the information provided by the integrator, it is possible to calculate the amount of erucic acid present in the original oil sample. ■



BLOOD-SUCKING FLIES, a hazard to western livestock

J. A. SHEMANCHUK and K. R. DEPNER

Des recherches intensives devront être entreprises dans le but d'empêcher que des parasites comme le maringouin, la mouche noire, le taon du cheval, le chrysop et le brûlot ne réduisent la productivité des bestiaux dans les régions irriguées et dans les vastes étendues du nord-ouest du Canada.

The demand for beef in Canada at the present time is strong and all indications are that it will increase by 50 per cent by 1980. If this demand is to be met, beef cow populations will have to be increased proportionately so that sufficient feeder cattle will be available to supply the feedlots that finish cattle for the consumer market. To accommodate the expanding population of beef cows in western Canada more grazing range and grassland will be needed. This need can be met by:

Dr. Depner and Dr. Shemanchuk are biting fly specialists in the Veterinary-Medical Entomology Section of the CDA Research Station, Lethbridge, Alta.

- 1) increasing the productivity of the existing grazing ranges and grasslands.
- 2) converting into pasture and grassland some of the land now used for producing cereal grains, and
- 3) utilizing grazing range and grasslands in the northern areas of western Canada, which at present are not being used for agriculture.

If the increase in cattle numbers is to be accomplished by improving the production of the existing grazing ranges and grasslands or by converting some of the cereal crop lands to pasture, especially those in the low rainfall areas, some form of irrigation will be required. But irrigation, however well managed, contributes to the production of high populations of blood-sucking flies such as mosquitoes, blackflies, horseflies, deerflies, and no-see-ums. Studies conducted by the CDA Research Station, Lethbridge, Alberta, have shown that mosquito populations in irrigated areas, because of the existence of many temporary and permanent bodies of water that are suitable for mosquito breeding, are more than 20 times greater than in dryland areas. The creation of canals and ditches necessary to supply water to the fields

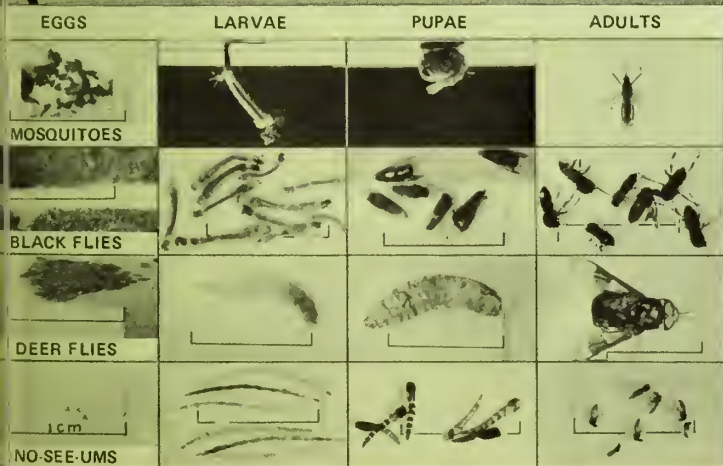


Fig. 1. (Top) A typical breeding ground for high populations of blackflies can be expected in this typical breeding ground in a northern area of western Canada.

Fig. 2. (Middle) This irrigation reservoir in southern Alberta is a suitable breeding ground for mosquitoes, horseflies, deerflies, and no-seeums.

Fig. 3. (Bottom) Stages of development of the four major blood-sucking flies common in western Canada are shown.

and to drain excess water off the fields has increased the amount of flowing water, which forms the breeding ground for blackflies. Before irrigation was introduced blackfly breeding sites were limited to natural rivers and streams. Sites suitable for abundant breeding of horseflies, deerflies, and no-see-ums have been created along the margins of irrigation canals, ditches, and reservoirs.

VAST BREEDING GROUND

The vast area lying east of the Rocky Mountains, extending north from Edmonton to the Yukon and including the Peace River Country, is one of the last great reserves of land in Canada suitable for agricultural and industrial development. Whereas the present development in this region is based primarily on oil, minerals, and lumber, agriculture will develop in the near future and will probably emphasize the production of livestock.

Because one of the major hazards to living in these northern areas is the blood-sucking flies, we have recently been conducting preliminary investigations on these insects in two northern localities in Alberta, the County of Athabasca and the Fort Vermilion district. The results indicate that because of the abundance of breeding grounds in these areas for mosquitoes, blackflies, horseflies, deerflies, and no-see-ums, these blood-sucking flies may well restrict the production of livestock in northern areas of western Canada. We know that many different species of blood-sucking flies are present in these areas, but we need more precise knowledge on their distribution, abundance, and behavior. All blood-sucking flies are potential carriers or transmitters of livestock diseases. Livestock in these areas may come in close contact with wild animals that may be reservoirs of diseases that could affect livestock. Little is known about the diseases of wild animals or the extent to which they may be passed to domestic animals introduced to the new areas.

The distribution, abundance, and behavior of blood-sucking insects affecting livestock in the irrigated and northern areas is being investigated intensively by the CDA Research Station, Lethbridge. Only when sufficient knowledge has been gained can measures be developed that will have a reasonable prospect of success in reducing the hazards from blood-sucking flies. More research is needed in developing various methods of biological and chemical control of these pests, and in studying the diseases they transmit. We have every reason to believe that the losses caused by blood-sucking flies can be reduced and that the possibility of serious outbreaks of diseases can be held to a minimum, if not prevented. Thus, through utilization of the northern areas or increased production in existing grazing and grasslands, the continuing viability of the livestock industry in western Canada will be assured. ■

ECHOES

FROM THE FIELD AND LAB



These Canadian holstein bulls in the exercise yard at the Canada Agriculture Central Experimental Farm in Ottawa may have a role to play in future Canadian exports to Russia. A recent Canadian mission to that country found Soviet interest high in increased imports of cattle and cattle semen from Canada, as well as in the exchange with Canada of genetic stocks from various breeds.

BEEF CARCASS APPRAISAL SERVICE A Beef Carcass Appraisal Service has been instituted by Canada Department of Agriculture, Livestock Division, Ottawa, to provide producers of feeder calves and finished cattle with detailed carcass information after their animals have been slaughtered. The data on such grade-out factors as warm carcass weight, quality, grade, area of rib-eye and fat measurement can be used by producers to evaluate breeding, feeding and management programs.

A special CDA ear tag which is distinctive in color and design can be purchased from the Livestock Division, Ottawa, for \$1.00 per tag (and \$3.00 for the applicator). The purchaser of tags may put tags on selected animals at any period during the animal's lifetime. Once tagged, the animal will carry the identifying number through the various marketing stages and into the slaughter house. When the animal is slaughtered, the tag will be removed from the ear and affixed to the carcass by the federal meat inspector at the plant.

Carcass grade-out data will be provided by the federal livestock graders at the plants, and relayed to the tag purchasers by the Division in Ottawa.

The Livestock Division will register the purchaser's name, carry out a detailed carcass appraisal, and provide the registered purchaser

with the following information: (a) place of slaughter; (b) date of slaughter; (c) ear tag number; (d) warm carcass weight; (e) quality grade; (f) area of rib-eye; (g) fat measurement; (h) marbling score.

More detailed information on the Carcass Appraisal Service may be obtained from the Livestock Division, Canada Department of Agriculture, Ottawa, K1A 0C5. — F. E. PAYNE, CDA LIVESTOCK DIVISION, OTTAWA.

SERVICE D'APPRECIATION DES CARCASSES DE BOEUF

La Division des bestiaux du ministère de l'Agriculture du Canada, à Ottawa, a institué un Service d'appréciation des carcasses de bœuf dont le but est de fournir aux producteurs de veaux gras et de bovins finis des renseignements détaillés sur les carcasses de leurs animaux après abattage. Des données sur des facteurs de classement tels que le poids de la carcasse à chaud, la qualité, la catégorie, la surface de noix de côtes et la quantité de gras peuvent se révéler profitables aux producteurs pour établir leurs programmes d'élevage, d'alimentation et de gestion de leurs troupeaux.

On peut acheter, à la Division des bestiaux, des plaquettes ou marques d'oreille du Ministère, de couleur et de forme spéciales; elles se vendent \$1 par plaquette (\$3 pour les pinces). On peut placer ces plaquettes à l'oreille des animaux à n'importe quel moment de leur vie. L'animal étiqueté portera son numéro d'identification pendant toutes les transactions et jusqu'à l'abattoir. Au moment de l'abattage, l'inspecteur fédéral des viandes responsable de l'établissement enlèvera la plaquette de l'oreille et la fixera à la carcasse.

Les inspecteurs fédéraux des bestiaux dans les abattoirs enverront les données sur le classement des carcasses à la Division, à Ottawa, qui les mettra à la disposition des producteurs.

La Division des bestiaux consignera le nom de tous ceux qui achètent les plaquettes, établira une appréciation détaillée de la carcasse et fournira à l'acheteur de plaquettes les renseignements suivants: a) lieu et b) date de l'abattage; c) numéro de la plaquette d'oreille; d) poids de la carcasse à chaud; e) classement de la qualité, f) surface de noix de côtes; g) quantité de gras; h) notation du persillage.

On peut obtenir de plus amples renseignements sur le Service d'appréciation des carcasses de bœuf en s'adressant à la Division des bestiaux, ministère de l'Agriculture, Ottawa K1A 0C5.—F. E. PAYNE, DIVISION DES BESTIAUX, OTTAWA.

THE LIFE OF AN AGRICULTURAL TECHNICIAN Youths who are not interested in university graduation are really coming into their own today, with the help of institutions such as the Vocational and Technical Training unit at the Nova Scotia Agricultural College.

According to Dr. L. B. MacLeod, Director, CDA Research Station, Charlottetown, P.E.I., there is wide scope for gainful employment, a good life and personal satisfaction as an agricultural technologist.

"Admittedly," says Dr. MacLeod, "technicians and technology graduates won't command salaries equal to those of people who have graduate or postgraduate training." But he points out the following comparison:

"At the Charlottetown Research Station, technicians and technology graduates are hired at \$7,000 to \$8,000; technologists with related experience are offered salaries in excess of \$8,000. The recruiting salary for a research scientist, with Ph.D. requirements completed, is \$11,100.

"Consider the technician graduate starting to earn, two to three years after high school, a respectable \$8,000 to \$9,000 salary for the ensuing five, six or seven years. During this period the degree student is still working toward his Ph.D., is not earning, and is, most likely, accumulating debts. Even without considering the interest accrued on the money he has earned in the intervening years, the technician will still be in a favorable financial position, will have accumulated a start on a home, or will have at least acquired considerable personal effects that the Ph.D. has yet to acquire. The technician will have advanced in his position, and his salary will be closer to the Ph.D. level even though his future earning power will not likely be as great."

Dr. MacLeod suggests that in view of these circumstances, the young man or woman contemplating a career should consider the more immediate opportunities and satisfactions offered by the technician's life, without the additional expenditure of money and time required for university degrees.

CANADA PLEDGES FOOD AID Canada continues to hold a leading place among countries contributing to the World Food Program. For the two-year period of 1973-74, Canada is pledged to donate \$34 million, of which \$26,520,000 will be in foodstuff, with the balance in cash.

Jointly sponsored by the United Nations and the Food and Agriculture Organization, the World Food Program (WFP), was established ten years ago to spur social and economic development by channelling excess

ECHOS

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food resources to countries in need. Because of this operation, food surpluses of member countries are no longer burned, dumped in the ocean or ploughed under, but are used to supplement inadequate food supplies in other areas.

Alert to the danger that food-aid could deteriorate into a disposal operation for surplus crops, WFP undertakes to dispense food and food products suitable to the recipients, and to ensure a balanced protein-calorie relation. In addition to making food supplies available where possible, WFP aids developing countries by using cash donations from member nations to: build local market roads; introduce drainage, irrigation, reforestation and resettlement schemes; establish school children feeding programs; assist with vocational training, and deal with food-shortage emergencies.

Canada's pledge to WFP for 1973-74, represents a \$4 million increase over the 1971-72 commitment. Seventy-four countries donate crops and cash to WFP but Canada and the United States consistently contribute more than two-thirds of the program.

A BOOST FOR FAIRS The Agricultural Fair means many things to many people. In a period of adjustment, it is natural that people with an interest in fairs are concerned with the changes that are going on. In the view of J. H. Cochran, Chief, Merchandising Section, CDA Livestock Division, the main objectives of an agricultural fair are, not necessarily in order of importance, as follows:

1. It should be of an educational nature aimed at promoting improved rural-urban relations, and promoting a broader consumer knowledge and appreciation for agricultural products.

2. The fair should improve our agricultural produce through competitive classes. With supermarket standards of merchandising, the consumer has become more sophisticated, and wants the best available.

3. The fair must be entertaining—but in what way? It's difficult for a fair to compete with television in the entertainment area. Young people have talent for music and dancing. It may be that this form of entertainment has the right kind of appeal for fair goers.

4. The fair can be used as a market place where potential buyers can gather to inspect the best seed stock and produce in the community.

Mr. Cochran is involved in the administration of a fund of \$10 million recently made available for immediate use by exhibition associations with plans for the construction, reconstruction, extension or improvement of fair facilities.

EGG EATING ON RISE IN THE WEST Mr. T. F. Wasylyshen, District Supervisor of the Poultry Division, CDA Production and Marketing Branch, Winnipeg, has completed a study on the per capita consumption of shell eggs for a number of provinces and areas of Canada. It serves to illustrate the eating habits of people in different areas over the last five years. The statistics suggest that shell egg consumption is on the decrease in B.C. and Alberta since 1967 and since 1968 in Manitoba, Ontario and Quebec.

There is a definite difference in the level of shell egg consumption between Western and Eastern Canada. Based largely on Manitoba's interprovincial sales of eggs, which ranged from 33% of total production in 1966 to 41% of total production in 1970, it would appear that Eastern Canada is eating even fewer eggs on a per capita basis than Western Canada, thus changing the level of consumption in Canada west of Manitoba.

FERTILIZERS AND WATER POLLUTION Under normal management practices, the application of fertilizers is not likely to constitute a hazard to water systems, soil scientists at the CDA Research Station, Lethbridge, Alta., have found. The scientists are primarily concerned with nitrates because they move more readily through the soil than any of the other plant nutrients supplied by fertilizers. Experiments have shown that eight years after heavy applications of up to 800 pounds per acre of nitrogen in the form of ammonium nitrate were made on rangeland, the downward movement of nitrates through the soil was less than five feet.

On the semi-arid prairie, runoff and excessive leaching are less common than in the more humid regions. Normally, crops consume more nutrients from the soil, than are supplied through fertilizer applications. Thus the scientists conclude that fertilizers should not be an important contributor to water pollution, except through runoff and erosion.

AQUATIC HERBICIDE SPRAYER

Alberta ecologists try out new carbon dioxide pressurized aquatic herbicide sprayer specially modified by scientists at the CDA Research Station, Lethbridge, Alta., for small scale control operations (half to one acre in extent). The compact, easily dismantled, ac-

curate sprayer has proved very effective on experimental areas for the underwater injection of aquatic herbicides for channel cutting and for shoreline applications for the control of algae and marginal emergent aquatic weeds.



Des expériences effectuées à Terre-Neuve démontrent que les terres sauvages couvertes d'Éricacées (bleuets, Kalmia, thé du Labrador) peuvent être transformées en grossiers pâturages. Des applications en surface, sans altération mécanique de sol, de pierre à chaux, de fertilisants et de graines donnent un bon rendement dans les sites plus favorables. Cependant, l'on obtient également de très bons résultats aux endroits couverts en surface d'une très dense végétation en employant un semeur spécial qui brise le sol.



ROUGH PASTURE DEVELOPMENT

Newfoundland has large areas of "barrens" which have been widely used for summer grazing. The carrying capacity of such areas has not been measured but animals come off in good shape in late September or early October after about four months grazing. The era of free grazing, however, is now practically over since herd laws are gradually being enforced. Town councils have banned the free grazing of roadside and common lands under their jurisdiction and the Provincial Government has taken over suitable areas of barrens and fenced them for community pastures. As time and money permit, the land within community pastures has been limed, worked with a heavy Rome disc, fertilized, seeded and finally smoothed over with a chain harrow. Also, where suitable peat soils were available within a pasture area, they were drained, limed, rotovated, fertilized and seeded and have provided an excellent supplement to pastures on mineral soils, especially in dry summers.

Early in the development of community pastures it was recognized that a full land clearing operation was both time consuming and costly. This article will review results of experiments conducted over the

past 14 years by the Research Station at St. John's West, in close co-operation with provincial authorities, to evaluate methods of range improvement with minimum cultivation.

BLUEBERRY BARRENS

Preliminary work was done at the Bay Roberts community pasture located on a ridge of typical "blueberry barrens" surrounded by ponds and interspersed with peat bogs or low hills covered with shrubby "heath" or blanket peat. Initial results showed that blueberry barrens could be improved simply by broadcasting limestone, fertilizer and seed, without "breaking" the solid surface. Comparisons were made between combinations of 0, 2 and 4 tons of limestone and 0, 300 and 600 lbs of 6-12-8 fertilizer in all combinations on the establishment and yield of a pasture mixture. The mixture of timothy, orchardgrass, creeping red fescue and white clover was broadcast over the fertilized plots which covered about one acre of open sod covered with blueberry, hair fescue, brown top and other forbs and shrubs. The area was moderately grazed by sheep during the 4 year experimental period and results from caged samples showed that fertilizers alone primarily stimulated native grasses, while limestone and fertilizer were necessary for satisfactory establishment of

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Fig. 1. Trefoil-timothy on Burin Peninsula.



Fig. 2. Seeded strips near Riverhead, St. Mary's Bay.

IN NEWFOUNDLAND

seeded grasses and clover. The best treatment was 4 tons of limestone per acre with annual dressings of 6-12-8 fertilizer at 600 lbs per acre. This improved production to over 3000 lbs of dry forage per acre of 20% clover composition in the third and subsequent years, compared to 200 lbs of wild grass from the check.

It was recognized however that there were other types of barrens, ranging from shallow mossy blanket peats of coastal areas to densely shrubby heath peats which often followed denudation by forest fires. A series of plots using the best treatment from previous experiments was set out in areas dominated by blanket peats on the south coast of the Avalon peninsula. Catches of grass-clover mixtures were excellent where the peat cover was very shallow or discontinuous, but heavy layers of peat, especially those derived from *Rhacomitrium* moss, prevented normal establishment and growth. This probably resulted from poor contact between the seed and the soil and it is felt that a suitable type of seeder would improve results.

ROLLER TYPE SEEDER

Previous experiments with a roller type seeder were quite successful in seeding peat bogs. This implement consisted of a 4 ft. diameter, water-weighted drum fitted with steel girdles at 9 inch intervals to

press the seed into the soil. It was tried on the Burin peninsula as a range seeder on blanket peat densely covered by lamb kill, labrador tea and some alders. Limestone at 3 tons per acre and 6-12-12 fertilizer at 600 lbs per acre were spread alone and in combination in parallel strips of $\frac{1}{3}$ acre each. One end of the field was cultivated by a Rome disc while the other end was left in the virgin state. Different mixtures of grasses and inoculated legumes were seeded across the field. Mixtures of Climax timothy with LaSalle red clover and Empire birdsfoot trefoil produced excellent stands on the areas receiving both limestone and fertilizer, with productivity values very similar to those obtained in previous surface seeding experiments (Table 1). The very high legume production from birdsfoot trefoil was notable and with annual dressings of 5-10-30 fertilizer at 300 lbs per acre, stands have been maintained for six years. The seeder was later modified by the addition of two distributor boxes in tandem, one for limestone and one for fertilizer.

In 1969, experimental seedings were conducted on blanket peat near St. Shotts (May 10), on shallow peat covered by heath plants and grass near Foxtrap (June 20), and on shallow peat covered by dense heath near Riverhead (June 28). The seeding at St. Shotts was a failure, probably due to a long cold pe-

TABLE 1. PRODUCTION AND COMPOSITION OF SURFACE SEEDINGS ON THE BURIN PENINSULA, IN THE THIRD YEAR AFTER SEEDING

Mixture and seeding method ¹	Yield, lbs dry matter per acre			
	Legume	Grass	Total forage	Native weeds
Clover-timothy: disced and seeded	352	2693	3045	256
Clover-timothy: seeded directly	426	2228	2654	434
Trefoil-timothy: seeded directly	1319	1908	3227	131

¹Limestone broadcast at 3 tons/acre and 6-12-12 at 600 lbs/acre and annual applications of 5-10-30 at 300 lbs/acre.

Fig. 3. (Below) Broadcast surface seeding, Bay Roberts.

Fig. 4. (Bottom) Roller seeder with lime, fertilizer and seed boxes.



riod after seeding. Moderately good stands were obtained at Foxtrap while excellent stands were obtained at Riverhead. In the latter seedings, Lakeland red clover, and Empire and Leo birdsfoot trefoil were each seeded with a mixture of creeping red fescue and Climax timothy. Relative to the Burin peninsula seedings, red clover was a better producer than trefoil.

The provincial Division of Agriculture has taken a keen interest in the experimental results obtained and has successfully improved sizeable community pasture areas using surface seeding methods. Following results obtained with the experimental seeder, they purchased a California seeder¹ which has now completed a full season's work. However, this seeder was designed for mineral soil and instead of leaving a hill of loose material for following drag weights to cover the seed, a ribbon or organic material was often left on the surface with the seed lying exposed in the drill. It seems likely that a pair of splitting discs might be more satisfactory than the single scalping disc now used to open each drill.

CONCLUSIONS

Based on the experimental and practical evidence summarized above, the following conclusions are drawn:

- (1) The natural vegetation of Newfoundland barrens is favored by the extremely low nutrient level of the soil, and sod-forming grasses are very limited.
- (2) When the soil nutritional level is raised by addition of limestone and major element fertilizers there is an immediate stimulation of plants of higher nutritional requirements and if a sufficient density of adapted species is established, they will quickly smother the original vegetation. Although this is accomplished without cultivation or the use of herbicides it is not implied that these procedures are not beneficial, only that the cost-benefit relationship may be small for a very similar end result.
- (3) While the drum seeder used in the experiments was very suitable for peat work, it was less satisfactory on barren lands where numerous stones and rock outcrop caused considerable bridging and uneven seeding. It is quite possible that with modifications, the California seeder would be more suitable for rough and irregular terrain.
- (4) The placement of limestone and fertilizer simultaneously with seed has been successful. Some of the best results were obtained when seed and limestone were banded together and fertilizer was banded slightly to the side. One clear advantage of the combined application is that in very rough terrain, random coverage can be made without fear that limestone, fertilizer or seed would be misqdd. Follow-up maintenance fertilizer would be applied only where vegetative growth warrants it. ■

¹J. E. Street, B. L. Kay and C. F. Walker. 1958. Drill seeding of forage ranges. *California Agric.* 12(10):5-6.



CHERRY FRUIT FLIES IN THE OKANAGAN VALLEY

F. L. BANHAM

Le cycle évolutif de la trypète des cerises fait l'objet d'une étude approfondie à la Station de recherches de Summerland. Cet insecte menace sérieusement la culture de la cerise douce en Colombie-Britannique. On tente de limiter sa propagation et de trouver des moyens de répression efficaces.

Two species of fruit flies attack cherries in the Okanagan Valley of British Columbia. The black cherry fruit fly, *Rhagoletis fausta* (Osten Sacken), was first recorded on cultivated cherries in this area in 1951 and the western cherry fruit fly, *R. indifferens* Curran, in 1968. Cherries attacked by either species are unmarketable because of maggots, frass, or flesh breakdown that follows maggot feeding. Because maggot-infested or damaged cherries are difficult to detect during the grading operation, packers and processors often reject total shipments when only a few of the fruits are infested. Life history and control of cherry fruit flies is a subject of active research at the Summerland Research Station in British Columbia.

Adults of both species are about half the size of a housefly and have black, banded wings. Black cherry fruit flies overwinter as pupae in the soil and emerge from late May to mid-July. Western cherry fruit flies emerge from early June to early September. After 7 to 14 days, females lay single, ovoid eggs beneath the skin of either sweet or sour cherries. Each female lays an average of 55 eggs. Larvae hatch in 6 to 10 days and feed for 10 to 18 days by tunnelling in the flesh of the cherry, mainly around the pit. When the maggots are about three-quarters grown, they cut one or

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more exit holes through the skin of the fruit. These holes are the first visible evidence of maggot feeding. At this stage, maggots drop from the fruit to the soil and burrow beneath the surface where they pupate and remain until the following summer. A few pupae may remain in the soil for two winters. There is generally one generation per year although about four percent of the flies produce a second generation.

ATTEMPTS AT ERADICATION

Following discovery of the black cherry fruit fly in 1951, an apparently successful eradication program was conducted the next year. This species was not reported again until 1965, when a maggot infestation was found in a commercial block of sour cherries. The following year all cherries in and adjacent to the original infestation were sprayed but eradication was unsuccessful. In 1968, yellow sticky board traps set out to monitor this species caught two western cherry fruit fly adults. In surrounding areas, additional sticky board traps were set out and extensive sampling of cherries was conducted to detect evidence of maggots or feeding damage. A second infestation of this species was located at Okanagan Mission, near Kelowna, B.C.

Throughout the Pacific Northwest, the western cherry fruit fly is the most difficult species to control. Adults emerge over a much longer period than those of the black cherry fruit fly. Renewed efforts made to eradicate or at least contain infestations of both species in the areas of the original outbreaks again were unsuccessful. The Plant Protection Division of the Canada Department of Agriculture conducted an

adult trapping survey throughout the Okanagan Valley to establish quarantine boundaries. This permitted the continuance of export certification for cherry shipments to some foreign markets. A few western cherry fruit flies were trapped at widely scattered locations from Vernon at the north end of the valley to Okanagan Falls 85 miles to the south. Most of the flies were trapped in abandoned cherry trees and seedlings. To date, no flies have been found at Oliver or Osoyoos at the south end of the Okanagan Valley or immediately west in the Similkameen Valley.

Since 1968, the western cherry fruit fly has continued to spread at an alarming rate. In contrast, the black cherry fruit fly is rarely found. The rapid spread of the western cherry fruit fly in the Okanagan Valley was thought to be associated with the presence of its principal native host, bitter cherry, *Prunus emarginata* Dougl. Although western choke cherry, *P. virginiana* var. *demissa* (Nutt.) Torr., a secondary native host, is abundant throughout the valley, the status of bitter cherry was unknown. An intensive search for this host was undertaken by the author in 1970 and 1971. Bitter cherry was located at six widely separated, protected sites in the central and northern regions of the valley. None of the stands was over 2.5 acres and all were within ¼-mile of Okanagan Lake. Premature fruit drop in 1970 and 1971 and symptoms of heat and moisture stress indicate the central and northern regions of the Okanagan Valley are marginal for this host plant. A few western cherry fruit fly adults, trapped in stands of bitter cherry in both regions, indicate that this host is





Fig. 1. (Left) Adult female western cherry fruit fly, poised on cherry over exit holes made by one or more emerged mature maggots.

Fig. 2. (Above) Damage in cherry caused by feeding of western cherry fruit fly maggot.

a factor in the ecology of isolated, low endemic populations of fruit flies. The rare occurrence of bitter cherry is unlikely to have influenced the rapid spread of the western cherry fruit fly in cultivated cherry plantings. There is no evidence to indicate that endemic populations on native hosts have formed a strain adapted to development in the fruit of earlier maturing, cultivated cherry. Thus, there may be two distinct host races: an isolated, endemic race on native hosts and a widespread recently introduced race on cultivated cherries.

COMBINED EFFORT

The western cherry fruit fly has continued to damage cultivated cherries since 1968, when an effective control program was quickly devised and implemented under the combined efforts of the British Columbia Department of Agriculture and the Summerland Research Station. Initially, cherries were sprayed with insecticides used in other areas to kill adult flies before eggs could be laid in the fruit. Yellow sticky board traps, attractive to the adults, were hung in cherry trees and inspected at regular intervals to determine the need for treatment and the optimum timing for maximum effectiveness. Results showed a maximum of 3 to 5 sprays at 10-day intervals were necessary, depending on maturity dates of the cherry varieties and the time required to complete harvest.

An extension program, developed jointly by the Canada and British Columbia Departments of Agriculture, was conducted in 1970 and 1971, to acquaint commercial growers and backyard gardeners with the damage caused by both species of cherry fruit flies. Each summer, three university students were hired by B.C.D.A. to demonstrate to growers the use of sticky board traps, how to identify the flies and the current recommended control procedures. Over 6,000 traps are used annually to improve treatment effectiveness and ensure that insecticide sprays are used only if needed.

Currently, the use of systemic insecticides is under investigation at the Summerland Research Station to reduce the three to five sprays now recommended to one or two. The effectiveness and persistence of insecticides applied as conventional sprays, as attractant-insecticide combinations or as bands on the tree bark, are being determined in the field against natural populations of flies and in the laboratory against flies incubated from stored pupae. Rates of insecticide degradation are established in the laboratory by caging flies on foliage and fruit samples taken from the field at intervals following treatment. Preliminary investigations indicate these chemicals will kill adults as well as eggs and young maggots in the fruit. New adult traps which utilize color and attractant baits will be tested to determine if combinations can be found that are more attractive than the yellow sticky board trap now used. ■

EGG SHELL FORMATION

Use of skeletal mineral (calcium) by hens is important to egg producers

A. C. COX

Des études, sur la formation des coquilles des œufs de poule indiquent que les fermiers et les poules ont le même but: une coquille résistante. C'est le squelette de la poule qui cependant paye la note.

The consumer is more interested in what is inside an egg than what surrounds it. An egg producer thinks differently. He considers the egg shell the most important part of an egg, for without a good shell the product could not be marketed profitably. Not only that, but the shell protects its contents from possible entry of micro-organisms. Of course, it also protects the developing embryo, during incubation, from the outside world and supplies it with calcium.

The egg shell is almost entirely calcium—95% to be exact—so the formation of a shell depends largely on calcium metabolism. If a hen does not get enough calcium in her diet she draws on her own bones—this has been the object of our research at the CDA Research Station, Kentville.

Calcium metabolism of the reproductively active hen is dynamic. Even on a day a hen does not lay, her maintenance requirement for calcium is approximately 100 milligrams while on a day a good quality egg shell is mineralized, approximately 2100 milligrams of calcium are metabolized. Also, an amount of calcium equal to the total in the hen's circulatory system turns over every 12 minutes during egg shell formation, and in one year that a laying hen producing 250 good quality eggs, she metabolizes an amount of calcium equal to approximately 20 times that in her body.

In fact, a medullary or secondary bone system begins to develop in some of the hollow bones of her skeleton just prior to the onset of production. The hen draws upon these reserves during egg shell formation when the quantity of calcium obtained from the diet is insufficient to meet the demand for shell mineralization.

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There is considerable evidence both direct and indirect for the necessary resorption of skeletal mineral to some degree during egg shell formation. Reported radio-tracer estimates indicate that 25% to 65% of the total calcium in an egg has been derived from the skeleton of the hen. The hen must withdraw calcium from her body stores to produce a well calcified egg shell because she is unable to obtain calcium from her diet at the rate it must be secreted during egg shell formation. The maximum absolute calcium retention reported for a laying hen is 1.83 grams for a 24-hour period. A large egg contains between 2 and 2.5 grams of calcium. The difference between calcium "retained" and that in the egg must be derived from body stores. Also, it may be calculated that, during the period (16 hours) of calcification of a shell containing 2 grams of calcium, calcium must be withdrawn from the blood at a rate of 125 milligrams per hour. A daily retention of 1.83 grams would provide calcium at a mean rate of only 76 milligrams per hour. This again indicates a deficit between calcium obtained from the diet and that secreted during egg shell formation which must be covered by withdrawal from body stores.

Studies to date indicate that the skeleton plays a very important role as a source of mineral for egg shell formation at the onset of egg production. It is depleted of mineral beginning at the onset of production and the evidence to date indicates this depletion is linear during the production of approximately the first 25-30 eggs.

Figures 1 and 2 show the depletion of femur mineral that occurred during the production of the first 30 eggs in Experiments 1 and 2 respectively. The regression equation in Figure 1 indicates that femur bones were depleted of their mineral content at an average rate of 17.5 milligrams per kilogram of body weight per egg laid. Thus, a femur bone of a 1.4 kilograms pullet undergoing this average rate of depletion would have been depleted of 46.2% of its initial mineral content at the onset of production after her production of 30 eggs. The regression line in Figure 2 illustrates the much faster rate of depletion that occurred in Experiment 2. The average rate of femur bone mineral depletion observed in this experiment was 24.1 milligrams per kilogram body weight per egg laid. If we perform the same calculations as in the above example, after the production of 30 eggs

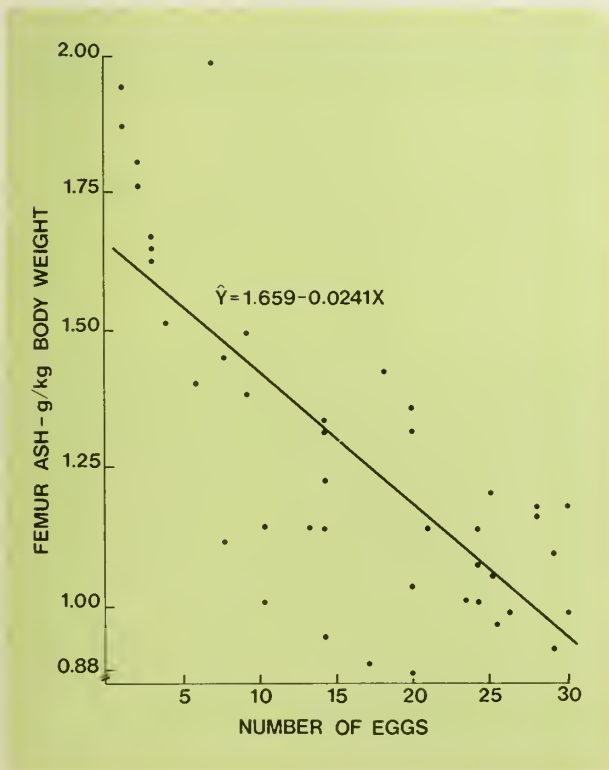
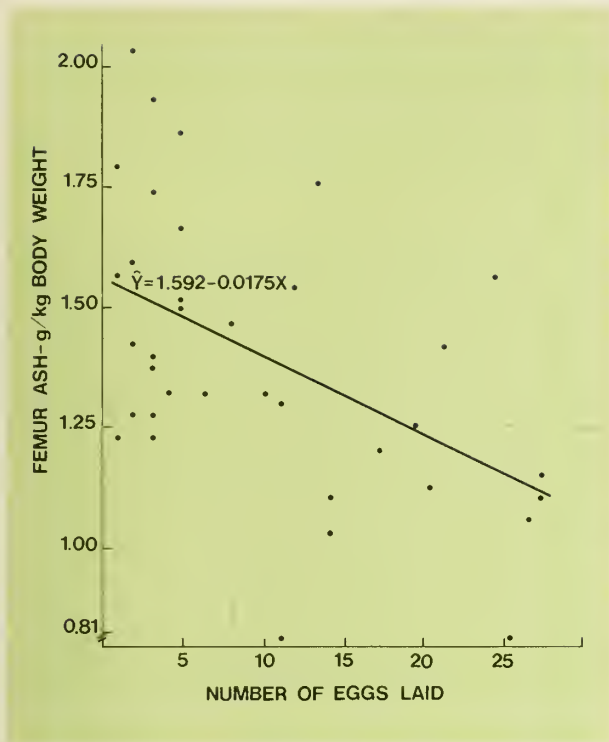


Fig. 1. (Top left) Rate of depletion of femur bone minerals in pullets during the production of their first 30 eggs. Experiment 1.

Fig. 2. (Bottom left) Rate of depletion of femur bone minerals in pullets which laid at a higher rate of production relative to those in Experiment 1 during the production of their first 30 eggs. Experiment 2.



Fig. 3. (Above) Depleted ashed femur bones (right) are from a pullet that laid at a much higher rate (hence more eggs) than the pullet from which the less depleted femur on the left was obtained.

the pullet's femur bone would have been depleted of 61.0% of its initial mineral content at the onset of production. The large difference between the rates of depletion observed can be explained in part by the different rates of production within the respective experiments. If the rates of depletion are adjusted for variation due to rate of production, they become 17.1 and 19.4 milligrams of femur ash per kilogram body weight per egg laid in Experiments 1 and 2 respectively.

The important role that the skeleton plays as a source of mineral for egg shell formation post onset of egg production has been shown in these studies. Further studies on this observed depletion of skeletal minerals immediately post onset of production are currently underway. The depletion of bone minerals to the extent of 53.6% on an average during the production of the first 30 eggs exemplifies the importance of the mineral nutrition of the pullet especially in the immediate pre and post onset of egg production periods. Research in the areas of mineral physiology and nutrition of the laying bird especially in these important periods is lacking and very much in need.

Figure 3 shows sections of ashed femur bones from pullets of the same age and raised under exactly the same management conditions. The depleted femurs (hollow) are from a pullet that had laid at a higher rate and hence more eggs relative to the pullet from which the less depleted femur was obtained. The degree of depletion that occurs can be appreciated from this picture. Depletion can progress in some cases to the extent that the bones fracture and in such cases, the hens must be destroyed at a substantial loss to the poultryman. ■

Des études portant sur les propriétés physiques des sols argileux indiquent que ceux-ci produisent d'excellentes récoltes comme le maïs, le soja et les tomates de transformation, mais nécessitent une gestion plus attentive que les autres sols.

If the physical condition of the approximately 2 million acres of fine-textured clay soils, predominant in southwestern Ontario, is kept up to par, then corn, soybeans, processing tomatoes and other row crops can be produced successfully in the warm growing season of this area.

In our research studies at Woodslee, we have found that these clay soils require better management than is required for other soils. For example, it is essential to follow tillage practices such as fall plowing, returning of crop residues, avoiding unnecessary tillage and traffic on wet clay soil—all are essential in addition to adequate fertility for optimum yields.

Our research program on clay soil was started in

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1946 when the Canada Department of Agriculture established the Soil Substation at Woodslee to measure effects of crop rotation on yield of crops grown on clay soil. In addition to yield tests, part of the program was directed to measurement of soil physical properties associated with cropping practice and soil treatment.

Soil physical properties such as particle size (texture) and aggregation of particles (structure) determine the environmental condition of the soil for plant growth. If a soil were composed entirely of clay particles, the extremely small size of these particles would result in close packing with a great many very small spaces in the soil mass. If a soil were composed of all coarse sand particles, there would be fewer but much larger spaces in the soil. Because of size, the small capillary sized spaces in the clay would normally be occupied by water while the larger non-capillary spaces in the sand would be occupied by air.

Agricultural soils are composed of both sand and clay particles in addition to soil aggregates or crumbs consisting of soil particles joined together. The amount and size of these soil aggregates depends to a large extent on the kind of tillage equipment used, cropping systems and other management practices.

Good soil physical condition generally exists where a soil is well aggregated and as a result is loose and crumbly. This soil tills easily and provides for favorable seed germination. It has been established that the total pore space between the soil aggregates

EFFECTS OF SOIL PHYSICAL CONDITION ON



will be 50% or more on a clay soil in good physical condition. The total pore space is available for air and water and usually the large air pores constitute 15-20% of the total soil volume in clay soils of south-western Ontario while the remaining 30% or more is available for water storage.

CROPPING AFFECTS SOIL

Crop rotations were the first experiments to be established on the clay soil at Woodslee in 1946 because it was considered that grass and legume crops were essential for producing economic corn and soybean yields. Grass and legume crops did improve soil tilth or soil physical condition in comparison with soil where row crops had been grown repeatedly.

Improved soil physical condition was indicated by total pore space (Table 1) which was 9 and 6% higher on a four-year rotation containing alfalfa than on continuous corn ground in 1968 and 1969, respectively. A two-year rotation of corn and oats also increased total pore space over that on continuous corn. Despite improved soil tilth the main factor limiting corn yield was nitrogen which was supplied either by preceding legume crops or as a chemical fertilizer. However, part of the yield increase, such as the yield increase on the corn-oats system in comparison with continuous corn, could be attributed to better soil tilth. Increased emergence, greater reliability of emergence and better crop growth accom-

panied the improved soil physical condition.

TILLAGE AND SOIL CONDITION

The main function of tillage on clay soil is to improve soil physical condition for plant growth. Basic tillage such as plowing loosens the soil and results in increased total pore space (Table 2) available for water storage and aeration. Fall tillage, particularly fall plowing is extremely important on clay soils since it provides a better soil moisture supply for crop establishment than spring plowing. Spring plowing results in adequate soil pore space but usually dries too quickly to produce suitable conditions for germination.

The amount of tillage required to prepare a seedbed on clay soil in the spring depends upon the kind of basic tillage used (Table 2). In this research, the most reliable seedbed preparation was fall plowed soil with two spring diskings, prior to planting, using tandem disks and levelling harrows attached. On fall plowing a minimum amount of seedbed preparation using levelling harrows only in the spring was satisfactory for corn but tended to make subsequent row cultivation difficult because the surface soil remained rough. Intensive seedbed preparation on fall plowing, consisting of seven diskings, failed to improve soil physical properties or corn yield (Table 3). Intensive seedbed tillage on spring plowing, on the other hand, did improve corn yield over lesser amounts of tillage but all yields on spring plowing were less than

An additional research site on clay soil was established in 1967 at Oil City about 25 miles from Sarnia in Lambton county. Experiments are in progress at that location on drainage, tillage and soil physical condition to solve production problems for that area and to provide soil-management information for a wider region.



CROP PRODUCTION

on fall plowed soil due to a less favorable moisture supply.

The risk of soil compaction through the use of heavier equipment has been a question of increasing importance on clay soils in recent years. Excessive equipment traffic, particularly on wet soil, has been shown to reduce total pore space (Table 4) which indicates that soil compaction has occurred. Normally only small changes in soil physical properties occur as a result of traffic on dry soil. Where soil has been compacted under wet conditions the freezing and thawing action of one winter can remove almost all compaction damage according to research at Wood-slee (Table 4). It should be noted that most clay soils in southwestern Ontario are bare throughout most of the winter months and are therefore favorably exposed to frost action.

SOIL CONDITION AND DRAINAGE

Clay soils in southwestern Ontario require subsurface tile for adequate drainage since the soil has poor permeability and the level topography restricts the surface drainage of water. Tile drainage systems have been installed over a period of many years on this soil. Practices which improve soil physical condition also increase soil permeability and enhance drainage. Methods of improving soil tilth and drainage include tillage such as fall plowing which mechanically loosens the soil or the return of crop residues and inclusion of grass and legume crops which increase aggregation.

NUTRIENTS AND SOIL CONDITION

There is little direct evidence to indicate that fertilizer use on clay soils is more efficient under conditions of good tilth. At the same time research has shown that adequate fertilizer, especially nitrogen, resulted in high productivity even where soil physical condition was at a relatively low level. However, the favorable effect of nitrogen was limited and total soil pore space was reduced to approximately 45%. At this level or below no amount of fertilizer overcame the impaired physical condition. ■

TABLE 1. EFFECT OF CROP ROTATION ON SOIL TOTAL PORE SPACE AND CORN YIELD

Crop system	Total soil pore space %		Corn yield bu / acre	
	1968	1969	1968	1969
Corn-oats-alf-alf	54.5	49.6	140.2	127.8
Corn-oats	52.5	47.1	119.3	113.4
Continuous corn	45.1	43.5	108.0	93.6

TABLE 2. EFFECT OF TILLAGE METHOD ON TOTAL PORE SPACE AND MOISTURE ON CLAY SOIL

Spring seedbed preparation on basic tillage						
Basic tillage	Mini- ¹ mum	Normal ²	Excess ³	Mini- ¹ mum	Normal ²	Excess ³
	Total pore space			Soil moisture		
	(Measured annually after planting)					
	%	%	%	%	%	%
	Fall					
Plow	48.8	51.6	50.0	25.2	26.5	25.6
Tandem disk	47.5	48.3	48.8	22.8	24.4	23.8
Spring						
Plow	51.8	51.9	50.6	23.8	22.6	22.9
Tandem disk	47.5	48.4	48.8	23.5	24.1	23.7

¹One harrowing with levelling harrows.

²Two tandem diskings with levelling harrows attached to disks.

³Seven tandem diskings with levelling harrows attached to disks.

TABLE 3. EFFECT OF TILLAGE METHOD ON CORN YIELD

Basic tillage	Spring seedbed preparation on basic tillage		
	Minimum ¹	Normal ²	Excess ³
	corn yield 4 yr av		
	bu / acre	bu / acre	bu / acre
Fall			
Plow	94.5	101.8	94.7
Tandem disk	62.5	91.9	87.3
Spring			
Plow	79.5	80.2	86.9
Tandem disk	69.8	77.0	89.3

¹One harrowing with levelling harrows

²Two tandem diskings with levelling harrows attached to disks

³Seven tandem diskings with levelling harrows attached to disks

TABLE 4. EFFECT OF TILLAGE TRAFFIC ON SOIL PORE SPACE AND CROP YIELD

	1959 treatments	1959 Total soil pore space %	1960* Total soil pore space after frost action %	Corn yield bu / acre
Minimum tillage*		51.6	49.7	102.2
Excessive tillage†		45.3	50.7	104.9

*Both treatments received only minimum tillage in 1960

*Tandem disked with levelling harrows attached in the spring on fall plowing.

†Tandem disked on fall plowing followed by tractor traffic until entire area was covered by rear tractor wheel. The area was then disked with tandem disks with levelling harrows attached

GREENHOUSE CUCUMBERS FROM HARROW



V. W. NUTTALL

Un programme de sélection du concombre est en cours à la Station de recherches du ministère de l'Agriculture du Canada, à Harrow, en Ontario. On cherche à obtenir des variétés à caractères distinctifs et attrayants, sans graines, douces, productives, et résistantes aux maladies, en vue de la production en serre.

Presently, 85 to 90% of the cucumbers grown under glass in southwestern Ontario are of the field type. The other 10 to 15% are the seedless or forcing type, developed by English and Dutch plant breeders, and grown commercially in greenhouses in Europe.

Cucumber breeding for the greenhouse industry in Canada started at the CDA Research Station, Harrow, Ont., in 1966. The objective is to develop seedless, bitter-free, disease resistant varieties with more appeal for the consumer. Plants that produce bitter fruits are being eliminated, and efforts are being made to incorporate the eating quality of European seedless varieties into the Harrow lines. It is also important that greenhouse cucumbers have resistance to diseases, particularly powdery mildew and cucumber mosaic virus.

A short term goal of the breeding program was achieved with the planting of the 1972 spring crop.

Mr. Nuttall is a specialist in vegetable breeding at the CDA Research Station, Harrow, Ontario.

Seed of an advanced true-breeding line was made available for limited testing under commercial production conditions. From these tests, the plant breeder will be able to assess production variability, shipping quality, shelf-life in supermarkets and consumer acceptance. This performance testing will determine whether the line merits more general introduction to the trade as a variety in 1973.

In general, the Harrow greenhouse cucumber lines will have a distinctive, uniformly dark green color. They will be longer than the North American seeded varieties but shorter than the European seedless to fit into home refrigerator compartments. The blossom-end, which tends to be pointed in greenhouse cucumbers, will be rounded or blunt in Harrow varieties yet to be named. They will also be free of the long, tapered stem-end neck or handle characteristic of European varieties and which require more space in shipping or on the shelf. Long stem-ends normally have no core which is associated with tender, crisp, juicy flesh.

A thicker, tougher skin has been incorporated into the Harrow lines to improve shipping and shelf-life qualities. Thinner skinned European seedless cucumbers often have to be covered in storage, or wrapped in plastic film on the supermarket shelf because the thinner skin often fails to preserve fresh condition.

Production and marketing trials going on now will determine whether the 1971 Harrow selection will be named and made available to the trade. By 1975, it is expected that other new varieties of F_1 hybrids, incorporating all the desirable features of greenhouse cucumbers, will be introduced. ■



P. PANKIW

A cause du danger d'infestation par un acarien parasite, les reines de ruche ne peuvent pas être importées de la plupart des pays. Ceux qui ne gardent des abeilles que durant l'été pourront importer leurs reines de la Nouvelle-Zélande au lieu des États-Unis comme l'ont révélé les essais d'abeilles importées. Les apiculteurs qui désirent hiverner les ruches avec des reines de Nouvelle-Zélande devront toutefois les remplacer en août avec des reines des États-Unis.

Beekeepers in Western Canada import over 200,000 packages of bees annually from the U.S.A.

Packages have been made up from colonies wintered in the Lower Fraser Valley, the Okanagan Valley, Vancouver Island and the southern Kootenay Valley of B.C. These colonies are either split into small divisions of bees and brood when the colonies are expanding rapidly after March 15, or surplus bees are shaken into two-pound packages in late April. However, supplying queens for both the divisions and the packages is a problem.

The only real source of queens has been the U.S.A. and here, the queens have been difficult to obtain because of the demand of the U.S.A. package bee industry.

Queens cannot be imported from most countries because of *Acarapis woodii*, a parasitic mite not normally found in Canada or the U.S.A. New Zealand is also free of the mite. And since their late summer, and off-season for honey production, corresponds with our new season, queens could be available from this source.

Dr. P. Pankiw is Head, Forage Crop Section, CDA Research Station, Beaverlodge, Alta.

THE PLACE FOR NEW ZEALAND QUEEN BEES IN CANADA



Beekeeper close to areas of high-density population may favor New Zealand queens because of their gentleness.

PERFORMANCE TESTED

In 1968 queens were imported from Frank White, Kamo, New Zealand under special permission of the Health of Animals Branch with the cooperation of the New Zealand Department of Agriculture. They were introduced into 2-lb packages obtained from colonies wintered in the Lower Fraser Valley near Abbotsford, B.C. A similar number of packages were headed by queens imported from California. Observations were made on brood rearing capabilities, gentleness, resistance to disease, swarming and honey production.

In the fall, colonies of each group were transported to Clearbrook, B.C. in the Lower Fraser Valley for wintering to determine their potential for production of package bees. Here again data were obtained on food consumption, and production of bees. Bees were shaken in late April and mid-May.

New Zealand colonies wintering in the Lower Fraser Valley at Clearbrook, British Columbia.



TABLE 1. PERFORMANCE OF NEW ZEALAND AND CALIFORNIA QUEENS IN SPRING BROOD-REARING AND HONEY PRODUCTION (1968-70)

	Average eggs per day 1 week after hiving	Average eggs per day 4 weeks after hiving	Honey production (lbs)
New Zealand	617	1069	151
California	694	1166	143

TABLE 2. PACKAGE BEE PRODUCTION AND CONSUMPTION OF FOOD OF NEW ZEALAND AND CALIFORNIA QUEENS. AVERAGE OF 3 YEARS

	No. of 2-lb packages produced	Food consumption (lbs) 8 month period
New Zealand	5.3	80
California	6.5	82

This 3-year experiment was completed in the spring of 1971. New Zealand queens were obtained through the New Zealand Department of Agriculture in 1969, and through A. Graham of Coaldale, Alberta, the Canadian representative of the New Zealand Bee Breeders' Association in 1970. Mr. H. Park of Pado Cedro, California provided the California stock.

On the average, New Zealand queens were a little slower to build up in the spring, as noted by their egg laying. However, they appeared to build up enough to collect as good a honey crop as the California stock (Table 1).

GENTLE BEES

Swarming was not a problem, possibly because greater care was taken in their management. New Zealand queens were more gentle than the California queens. This gentleness would be particularly useful for beginner beekeepers, 4-H bee clubs, demonstration hives at schools, or where bees are kept close to areas of higher density populations.

New Zealand stock was more susceptible to European foulbrood. Preventive feedings are therefore recommended for both package bee colonies and wintered colonies.

The wintering experiment (Table 2) showed that California stock was superior in production of package bees without any accompanying increase in food production. It appeared that the New Zealand colonies were slower in brood production during the early spring and this factor resulted in fewer packages produced.

Beekeeper who keep bees during the summer only could substitute New Zealand queens for queens from the U.S.A. Beekeepers who have New Zealand queens, and would like to winter, should replace them in August with queens from U.S.A. ■



T. A. GOCHNAUER, S. J. HUGHES and
JOHN CORNER

La maladie du couvain calcifié, causée par le champignon *Ascosphaera apis*, chez des larves d'abeilles domestiques, a été signalée pour la première fois au Canada en 1971. On ne connaît pas encore l'origine de cette invasion ni ses répercussions sur l'apiculture.

CHALKBROOD DISEASE OF HONEY BEE LARVAE . . .

A THREAT TO
CANADIAN
BEEKEEPING?

The honey bee occupies an important place in Canadian agriculture. Canadian honey is exported annually to the United States and Europe and during the past year Japan became an important buyer as well. The honey bee is a principal pollinator of a number of crops, such as legume seeds, tree fruits, berries, buckwheat, and rapeseed which also command attention in foreign markets.

Beekeeping is becoming more mobile as the beekeeper moves from area to area to provide pollination services under contract or to find better sources of nectar for his bees. This mobility increases the exposure of his stock to infectious diseases that decrease yields and threaten the destruction of his colonies.

Since 1950, many of these infectious diseases have been contained by commercially available antibacterial or antiprotozoan formulations developed by research at CDA stations. Little work, however, has been done on fungus diseases of bees. These have not been recognized in Canada, although they are well known in parts of Europe.

In 1971, honey bee larvae apparently infected with chalkbrood disease were found in Utah, California and Montana. This disease is caused by the fungus *Ascosphaera apis*, as described by Olive and Spiltoir, and it has been commonly isolated from diseased bees in Europe. The disease is now recorded for the first time in Canada.

Dr. T. A. Gochnauer is a member of the Entomology Section, Ottawa Research Station. Dr. S. J. Hughes is a member of the Mycology Section, Plant Research Institute, Ottawa. Mr. John Corner is Provincial Apiarist, British Columbia Department of Agriculture, Vernon, B.C.



Fig. 1. (Above) Infected honey bee larva, from Chilliwack, B.C.



Fig. 2. (Right) Infected larvae, bearing black spore cysts.

SYMPTOMS

In the spring of 1971, infected larvae were discovered in apiaries near Chiliwack, B.C., and Carrot River, Saskatchewan. The larvae found at Chilliwack appeared as chalky mummified flakes (Fig. 1) and some of those (Fig. 2) bore dark spots which were the spherical spore cysts of the fungus.

We do not know exactly what conditions are required for development of the infection. Some workers suggest that larvae can become diseased only if they are chilled during an early stage of infection; others speculate that attacks follow extensive use of antibacterial agents which permit the fungi to flourish.

One problem in understanding and appraising chalkbrood infection is that it may occur in the nests of some solitary or wild bees without causing apparent harm. Another problem is that several strains of the fungus seem to exist. It has a complicated life cycle, and two mating strains are required to produce development of the characteristic fruiting bodies or spore cysts. Strains that appear harmless in solitary bee nests could conceivably be infective if transferred to honey bee colonies.

Ways to control the disease by antifungal agents or by changes in management systems, or a combination of the two, are being sought.

Living cultures of *Ascosphaera apis* (DAOM 134568) are maintained in the culture collection of the Mycology Section of the Plant Research Institute, Ottawa. Dried cultures and the honey bee larvae from which they were isolated are also preserved in the Institute's National Mycological Herbarium. ■

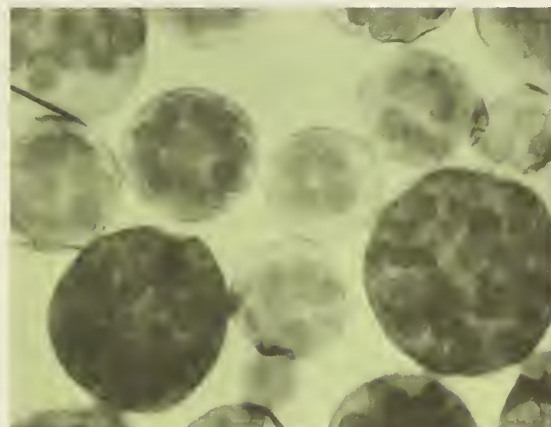


Fig. 3. Spore cysts of *Ascosphaera apis* isolated from Chilliwack sample on potato dextrose agar. The cysts average 65.8 microns (μ) in diameter. (Photo by Dr. L. K. Weresub).

PURE CULTURE Pure cultures of the fungus were readily obtained for research. On potato dextrose agar, the fungus forms abundant dark spore cysts (Fig. 3) which are 33 to 110 microns (μ), mostly 60 to 70 μ , in diameter. At maturity they contain a number of spore balls, each comprising an aggregation of minute ellipsoidal ascospores which are 2.4 to 3.7, by 1.4 to 1.8 μ .

Spiltoir and Olive (Mycologia, 47: 239-244, 1955) recognized two varieties of *Ascosphaera apis*. In the type variety they recorded spore cysts 32 to 99 μ , averaging 65.8 μ in diameter, and ascospores about 3 to 3.8 by 1.5 to 2.3 μ ; the Canadian isolate is evidently the same.

En mesurant le degré de résistance aux maladies, dans des variétés et des semis de pommes de terre, à la Station de recherches de Charlottetown, on a constaté une vulnérabilité plus ou moins grande à la pourriture des tubercules causée par deux espèces de fusarioses. On étudie présentement la valeur de certaines poudres pour le traitement chimique des graines. De nouveaux fongicides systémiques sont prometteurs pour le traitement des semences contre l'infection fusarienne.

At the CDA Research Station in Charlottetown we are cooperating with the Fredericton Station in an assessment of Fusarium tuber resistance in established Canadian and American potato varieties and in promising potato seedlings bred in Fredericton. We are also engaged in a study of Fusarium disease control by means of seed treatment.

Most Fusarium tuber infection, whether encountered in storage, in transit, or in shipments at point of destination, is initiated in wounds contracted during harvesting and grading of the crop. Fungal elements present in the soil become embedded in wounded tissues and decay becomes apparent in late fall or winter, the rapidity of decay being dependent on storage temperatures. Experiments conducted at Charlottetown have indicated that Fusarium inoculum does not overwinter in the soil. Rather, the inoculum is introduced at time of planting in the form of surface-borne seed piece contamination. The fungus prolife-

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rates during the growing season in the area of tuber production and the disease cycle is completed as infection becomes established in tuber abrasions.

By assessment of weather records compiled in Prince Edward Island, it has been determined that epidemics of Fusarium rot have been preceded by warm, dry conditions during the period of plant growth.

There are two *Fusarium* species associated with storage decay in the Maritimes, *Fusarium sambucinum* Fckl. f6 Wr. and *Fusarium coeruleum* (Lib.) Sacc. *F. sambucinum* f6 is primarily a storage decay organism while *F. coeruleum* may also cause serious seed piece decay either before or after planting.

VARIETY SUSCEPTIBILITY

Potato varieties differ widely in susceptibility to Fusarium storage rot and the varieties produced in an area have a bearing on the extent of decay in the stored crop. Our studies indicate that the varieties Sebago, Keswick, Norgold Russet, Kennebec and Pink Pearl are highly susceptible to decay caused by *F. sambucinum* f6 (Table). Records of tuber inspection indicate that under production practices the Sebago variety appears more susceptible to "sambucinum" decay than all other commercially grown varieties. With the exception of Hunter, varieties tested at Charlottetown were not classified as highly susceptible to decay caused by *F. coeruleum*, yet, under dry, warm conditions of growth followed by rough handling, rot caused by this organism may become severe in such varieties as Superior, Netted Gem, Keswick and Irish Cobbler. Kennebec and Wauseon are highly resistant to "coeruleum" decay and the variety Dorita showed an immune reaction in tests conducted in 1971.

FUSARIUM DECAY IN POTATOES



Recently conducted tests indicate that virus-free stocks of the Sebago and Kennebec varieties are much less susceptible to decay caused by *F. sambucinum* f6 than those infected with X and S viruses.

In the control of Fusarium decay, every effort should be made to avoid bruising during harvesting and grading operations. Tractor speeds must not be excessive, especially under dry soil conditions, and rubber insulation on elevator bars and graders should be maintained, as even small bruises will provide ideal infection sites for the storage rot organisms.

In research in progress at Charlottetown on the value of seed treatment dusts in the elimination of seed-borne inoculum of Fusarium pathogens, Polyram and mancozeb dusts have proven highly effective when used for the control of seed piece decay caused by *F. coeruleum*. These treatments resulted in better plant stands and increased yields when compared with untreated Fusarium contaminated seed. Similarly, both treatments applied to Sebago seed contaminated with inoculum of *F. sambucinum* f6 also resulted in increased yields. The systemic compounds Benlate (benomyl) and NF44 (thiophanate-methyl) have proven equally effective to the above compounds in reducing harmful effects of these seed borne pathogens. There is, however, an advantage with the systemics in that they provide effective control of seed borne verticillium wilt infection, whereas neither Polyram nor mancozeb have proven fungicidal against inoculum of the wilt organism. Neither Benlate nor NF44 are as yet registered for potato seed treatment and general commercial use must await additional knowledge relative to possible harmful crop residues. ■

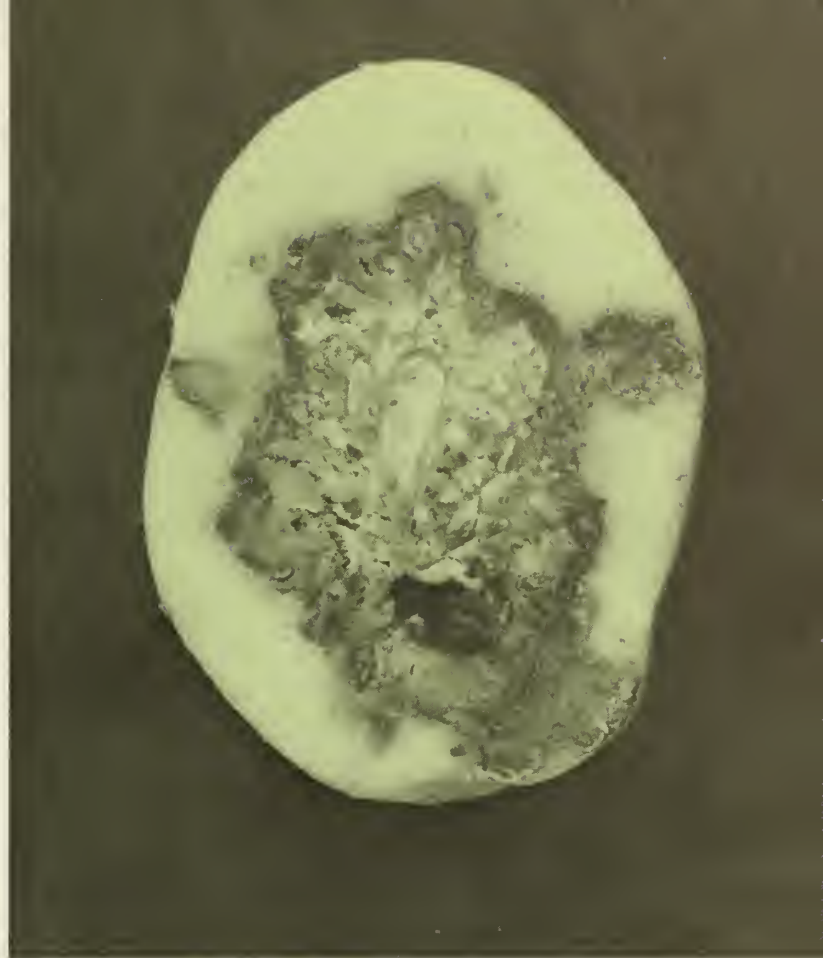
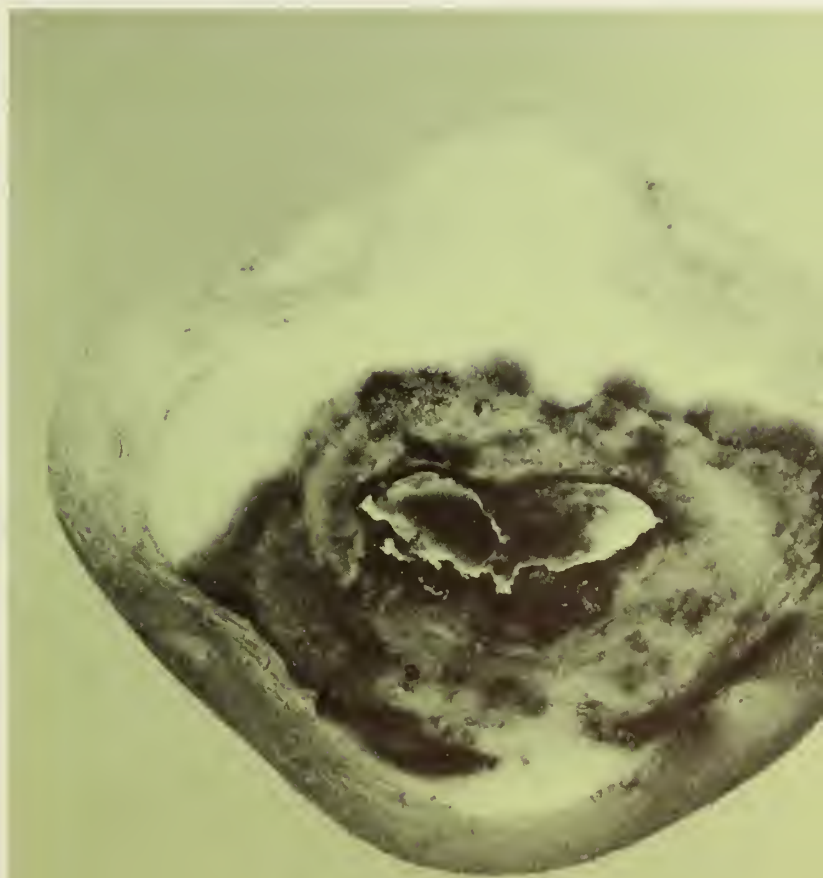


Fig. 1. Decay in Sebago variety caused by *Fusarium sambucinum* f6.

Fig. 2. Decay in Irish Cobbler variety caused by *Fusarium coeruleum*.



SUSCEPTIBILITY OF POTATO VARIETIES TO FUSARIUM STORAGE DECAY

Variety	Tuber reaction	
	<i>F. sambucinum</i> f6	<i>F. coeruleum</i>
Sebago	HS	S
Keswick	HS	S
Norgold Russet	HS	S
Kennebec	HS	R
Pink Pearl	HS	S
Green Mountain	S	S
Wauseon	S	R
Netted Gem	S	S
Norchip	S	S
Chieftain	S	S
Katahdin	S	S
Pontiac	S	S
Superior	R	S
Hunter	R	HS
Irish Cobbler	R	S
Red LaSoda	R	S
Dorita	R	R

HS = highly susceptible; S = susceptible; R = resistant.



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